Shared Accommodations Rack Verification Plan

Fluids and Combustion Facility

Rev. 1
Draft
January 5, 2001

AUTHORIZED by CM when under FORMAL Configuration Control	
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PREFACE

The National Aeronautics and Space Administration (NASA) is developing a modular, multi-user experimentation facility for conducting fluid physics and combustion science experiments in the microgravity environment of the International Space Station (ISS). This facility, called the Fluids and Combustion Facility (FCF), consists of three test platforms: the Fluids Integrated Rack (FIR), the Combustion Integrated Rack (CIR), and the Shared Accommodations Rack (SAR). This document presents the SAR Verification Plan, which is required by contract NAS3-99155 to show the verification process to be used on the FCF Project.

**SAR VERIFICATION PLAN
FOR THE
FLUIDS AND COMBUSTION FACILITY**

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REVISION PAGE
SAR VERIFICATION PLAN

Revision	Date	Description of Change or ECO's/ECP's Incorporated	Verification and Date
Draft	10/24/00	Initial	10/25/00
Rev.1	1/05/01	Revised based on NASA comments	01/08/01

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1.0 INTRODUCTION

1.1 Scope.

This plan is part of the FCF System and applies to all SAR hardware and software developed under the Exhibit 1 portion of the Microgravity Research, Development, and Operations Contract (MRDOC) contract. This plan establishes the organizational roles and responsibilities for verifying the SAR requirements, including ISS, science, and safety requirements and ground and on-orbit verifications. These requirements may be found in FCF-SPC-0004. This plan encompasses verification planning and the acquisition, reporting, and review of data leading to certification of the SAR spares and related support equipment.

1.2 Purpose.

This document defines the verification activities and associated management required to show the SAR complies with its requirements as identified in FCF-SPC-0004. This activity includes the verification of safety related verifications from the phased safety reviews, carrier requirements of SSP 57000 with associated SSP 57010 verifications, science requirements from FCF-DOC-002, and facility requirements as imposed by local authorities where the facilities are located.

1.3 TBD's.

TBD's are listed in Appendix D.

2.0 DOCUMENTS

This section lists specifications, models, standards, guidelines, handbooks, and other special publications. These documents have been grouped into two categories: applicable documents and reference documents.

2.1 Order of precedence for documents.

In the event of a conflict between this document and other documents referenced herein, the requirements of this document shall apply. In the event of a conflict between this document and the contract, the contractual requirements shall take precedence over this document. All documents used, applicable or referenced, are to be the issues defined in the Configuration Management (CM) contract baseline. All document changes, issued after baseline establishment, shall be reviewed for impact on scope of work. If a change to an applicable document is determined to be effective and contractually approved for implementation, the revision status will be updated in the CM contract baseline. The contract revision status of all applicable documents is available by accessing the CM database. Nothing in this document supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.2 Applicable documents.

The documents in these paragraphs of the latest revision or issue are applicable to the FCF Project to the extent specified herein.

CCSDS 701.0-B-2	Advanced Orbiting Systems, Network and Data Links: Architectural Specification, Blue Book
D683-10007	Fire Detection Assembly
D684-10056-01	International Space Station, Prime Contractor Software Standards and Procedures Specification
FCF-DOC-002	Science Requirements Envelope Document – Fluids and Combustion Facility
FCF-DOC-0016	Qualification and Acceptance Testing – Thermal Requirements
FCF-PLN-0023	Acoustic Control Plan
FCF-PLN-0027	Electromagnetic Interference/Compatibility Plan
FCF-PLN-0034	Mass Properties Control Plan
FCF-PLN-0036	Materials and Processes Selection and Control Plan
FCF-PLN-0037	Microgravity Control Plan
FCF-PLN-0053	Structural Design/Verification Plan
FCF-RPT-0061	Mass Properties Control Report
FCF-SPC-0001	Systems Specification International Space Station Fluids and Combustion Facility
FED-STD-595 Rev. B 12/15/89	Federal Standard Colors Used in Government Procurement
ISO/IEC 8802-3	Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specification

JSC, MA2-95-048	NASA IVA Touch Temperature Safety interpretation letter
MIL-C-5015 Rev. G(5) SUP 03/15/94	Connectors, Electrical, Circular Threaded, An Type, General Specification for
MIL-C-38999 Rev. J, 04/06/90	Connector, Electrical, Circular, Miniature, High Density Quick Disconnect, (Bayonet, Threaded, and Breech Coupling), Environmental Resisting, Removable Crimp and Hermitic Solder Contacts, General Specification for
MIL-C-81569	Connectors, Electrical Rectangular, Crimp Contact, General Specification for
MIL-C-83733	Connectors, Electrical Miniature, Rectangular Type, Rack to Panel, Environmental Resisting, 200° F Total Continuous Operating Temperature, General Specification for
MIL-HDBK-05	Metallic Materials and Elements for Aerospace Vehicle Structures
MIL-HDBK-27	Plastics for Aerospace Vehicles
MIL-HDBK-1553	Digital Time Division Command/Response Multiplex Data Bus Handbook
MIL-STD-1553B	Digital Time Division Command/Response Multiplex Data Bus Handbook
MIL-STD-1686	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices) Document
MSFC-SPEC-250	Protective Finishes for Space Vehicle Structures and Associated Flight Equipment, General Specification for Document
MSFC-STD-275	Marking of Electrical Ground Support Equipment, Front Panels, and Rack Title Plates
NASA-STD-5003	Fracture Control Requirements for Payloads Using the Space shuttle
NASA-STD-6000	Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for materials in Environments That Support Combustion
NHB 5300.4(1B) 04/69	Quality Program Provisions for Aeronautical and Space System Contractors
NHB 6000.1	Requirements for Packaging, Handling, and Transportation for Aeronautical and Space Systems, Equipment, and Associated Components
NSTS 1700.7	Safety Policy and Requirements for Payloads Using the Space Transportation System
NSTS 1700.7 ISS Addendum	Safety Policy and Requirements for Payloads Using the International Space Station
NSTS 1700.7 Rev B ISS Addendum	Safety Policy and Requirements for Payloads Using the International Space Station
NSTS 13830	Implementation Procedure for NSTS Payloads System Safety Requirements
NSTS 18798	Interpretations of National Space Transportation System (NSTS) Payload Safety Requirements

SN-C-0005	NSTS Contamination Control Requirements Manual
SSP 30237	Space Station Requirements for Electromagnetic Emissions and Susceptibility Requirements
SSP 30238	Space Station Electromagnetic Techniques
SSP 30240	Space Station Grounding Requirements
SSP 30242	Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility
SSP 30243	Space Station Requirements for Electromagnetic Compatibility
SSP 30245	Space Station Electrical Bonding Requirements
SSP 30262:013	Smoke Detector Assembly Standard ICD
SSP 30312	Electrical, Electronic, and Electromechanical Parts Management and Implementation Plan for Space Station Program
SSP 30423	Space Station Approved Electrical, Electronic, and Electromechanical Parts List
SSP 30426	External Contamination Control Requirements
SSP 30482 (V1)	Electric Power Specifications and Standards, Vol. 1: EPS Performance Specifications
SSP 30482 (V2)	Electric Power Specifications and Standards, Vol. 2: Consumer Restraints
SSP 30573	Space Station Program Fluid Procurement and Use Control Specification
SSP 41002	International Standard Payload Rack to NASA/NASDA Modules Interface Control Document
SSP 41017	Rack to Mini Pressurized Logistics Module ICD Part 1 and Part 2
SSP 50005	International Space Station Flight Crew Integration Standard (NASA-STD-3000/T) Document
SSP 50184	High Rate Data Link Physical Media, Physical Signaling and Protocol Specifications
SSP 50313	Display and Graphical Commonality Standard
SSP 52005	ISS Payload Flight Equipment and Guidelines for Safety Critical Structures
SSP 52050	Software Interface Control Document Part 1, International Standard Payload Rack to International Space Station
SSP 52054	ISS Program Payloads Certification of Flight Readiness Implementation Plan, Generic
SSP 57000	Pressurized Payloads Interface Requirements Document
SSP 57001	Pressurized Payload Hardware ICD
SSP 57002	Pressurized Payload Software ICD
SSP 57007	ISPR Structural Integrator's Handbook
SSP 57011	Payload Verification Plan
SSP 57020	Pressurized Payload Accommodations Handbook
SSQ 21635	Connectors and Accessories, Electrical, Rectangular, Rack and Panel
SSQ 21654	Cable, Single Fiber, Multitude, Space Quality, General Specification for Document

SSQ 21655	Cable, Electrical, MIL-STD-1553B Data Bus, Space Quality, General Specification for Document
TM104438	GRC Safety Manual

2.3 Reference documents.

The documents in this paragraph are provided only as reference material for background information and are not imposed as requirements.

SSP 41171	Preparation of Program-Unique Specifications
SSP 57000 Rev. D, 07/21/99	Pressurized Payloads Interface Requirements Document

3.0 FCF VERIFICATION

The FCF Project office will verify all the requirements imposed on the SAR. The primary sites for SAR verification activities will be the Glenn Research Center (GRC) and the item developer's site unless otherwise directed by the FCF or ISS Program. All requirements will be recorded in a database and disseminated to the design team. The database will improve traceability from the initial requirement through verification, guide the verification activities, track the status of the verification activities, and generate reports for the design team and the customer organization.

3.1 General.

The process for verifying the SAR and its constituent systems for flight certification on the ISS is presented in Figure 1. The figure illustrated the complexity of the process. Figure 2 provides the overview of the verification plans for SAR which incorporate all SAR science, performance, project, and safety verifications. Figure 3 shows the generic process flow for the payload verification within the SAR.

3.1.1 Categories for verification.

The verifications required for SAR categories consistent with the SAR lifecycle and usage covered by this plan are: Initial Launch, On Orbit, Mission Specific, Sub-Rack Payload, Integrated FCF/Payloads, and Upgrades. All requirements that can be verified on Earth will be verified in tests, analyses, inspections, and/or demonstrations before the subject hardware is launched. Subsequent verification of requirements or characteristics unique to the space environment that cannot be verified on Earth will be verified on orbit. All Sub-Rack Payloads and SAR upgrade hardware will be verified as subsystems. The results will be incorporated into the FCF verifications and the Verification Database to ensure earlier FCF System level certifications remain intact. If necessary, this hardware will be reverified after it is installed in the orbiting SAR before it experiences its first mission specific experiment.

3.1.2 Reporting.

Reports will be generated to identify the hardware being verified, requirements traceability, verification methods and status, and the individual(s) responsible for the verification activities. The final report generated against a requirement will be a comprehensive report intended to close out the requirement, upon which a Certificate of Verification is issued. The reports and database from which they are generated will be made available to the end users of the information. All data and reports generated as part of the verification process will be retained for the life of the FCF System, primarily in electronic format within the Verification Database (See Figure 3). Figure 4 gives the documentation flow from FCF to the ISS Program office.

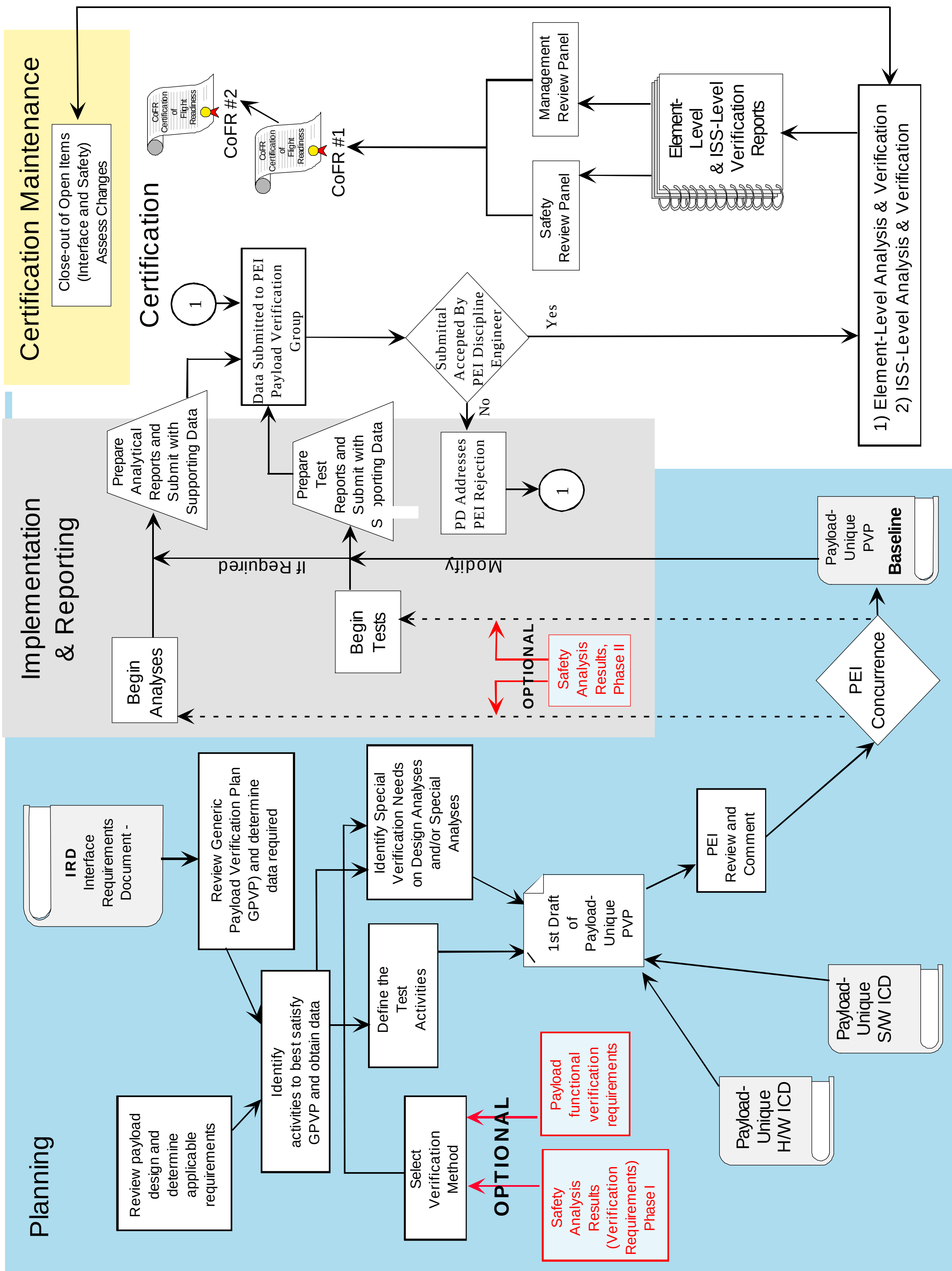
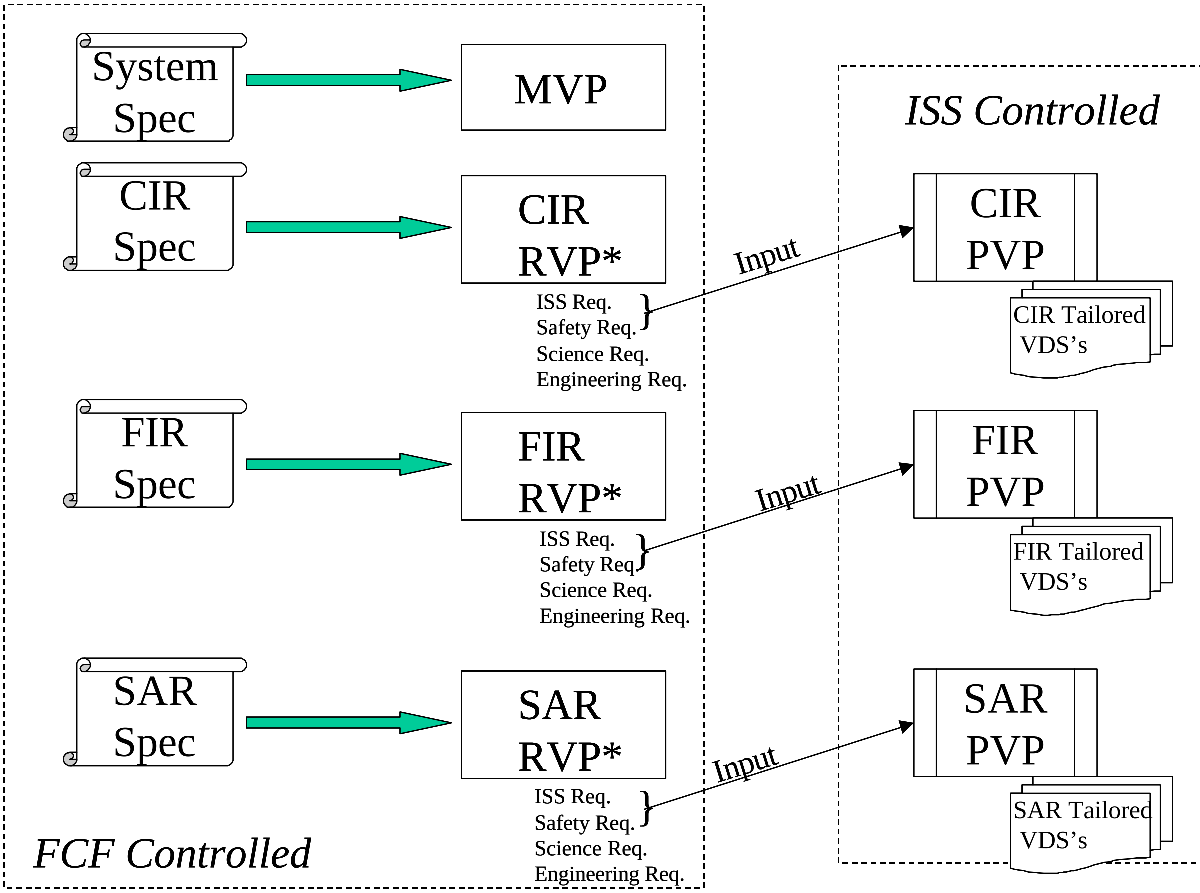


FIGURE 1. Requirements and verification process



* Requirements Verification Plan is used to distinguish between the MRDOC plan and the ISS Payload Verification Plan for FCF payloads.

FIGURE 2. FCF to ISS documentation flow

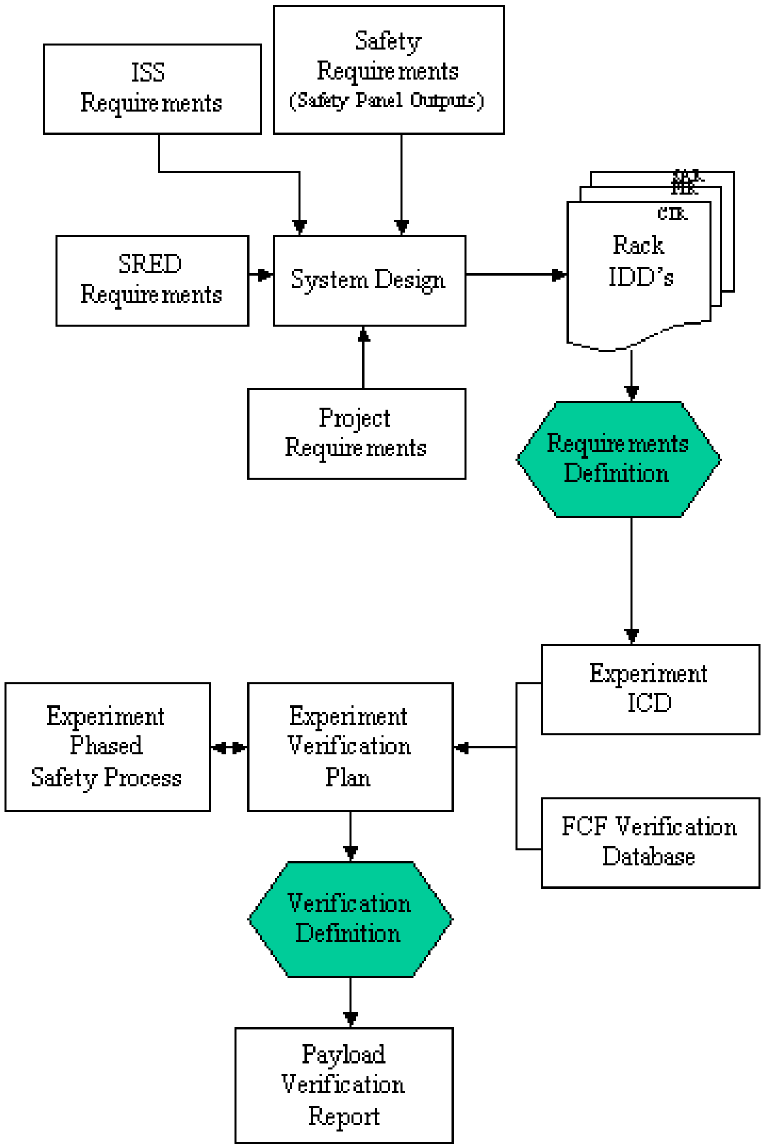


FIGURE 3. Payload integration process into SAR

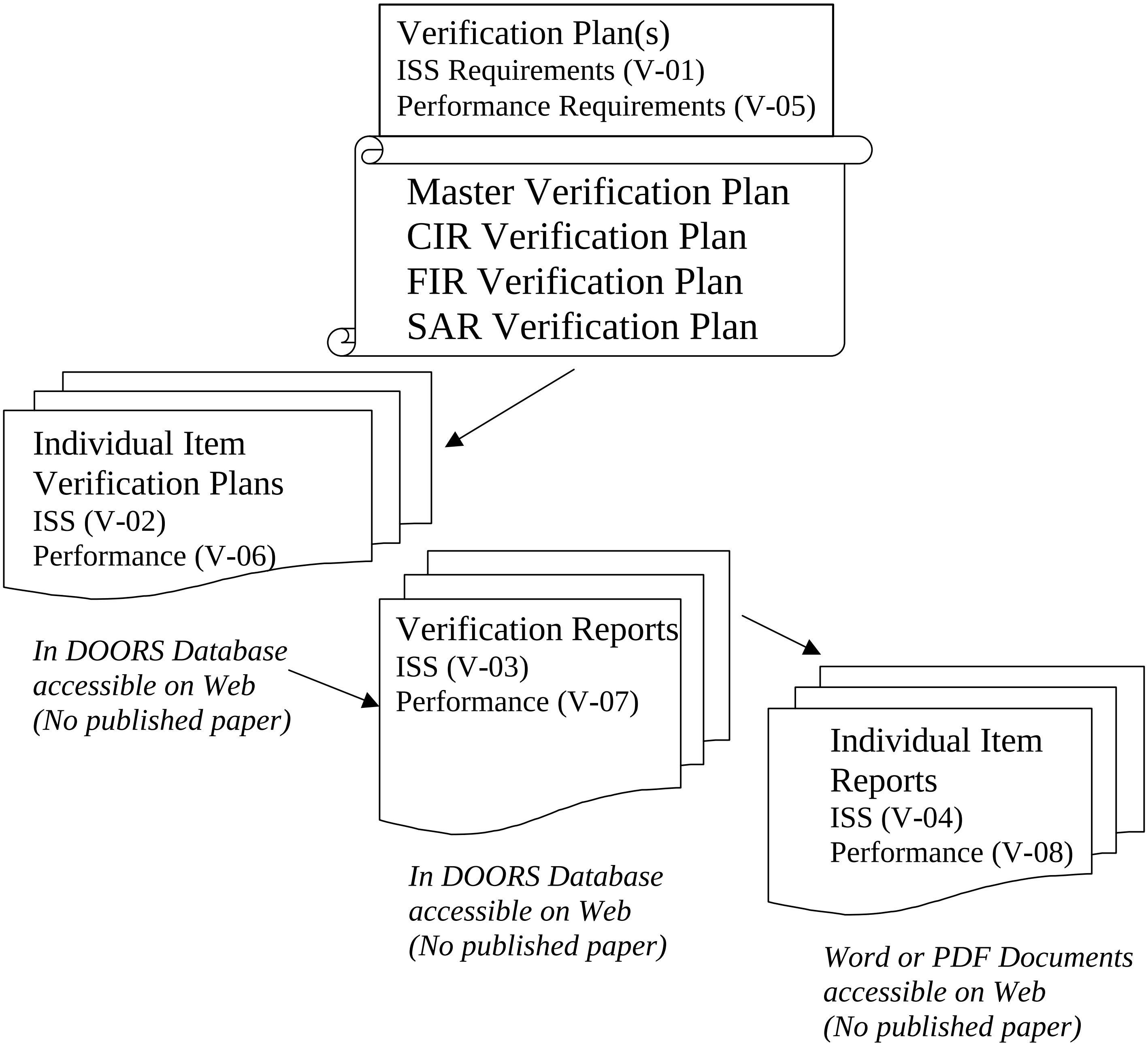


FIGURE 4. Verification documentation flow

3.1.3 Verification methods.

Test, analysis, inspection, and demonstration will be appropriately applied to the verification mission and the individual hardware items. These methods are defined below per SSP 41171:

a. Test (T) – Verification through systematic exercising of an item under all appropriated conditions. Performance is quantitatively measured either during or after the controlled application of either real or simulated functional or environmental stimuli. The analysis of the data derived from a test is an integral part of the test and may involve automated data reduction to produce the necessary results.
b. Analysis (A) – Verification by technical or mathematical models or simulation, algorithms, charts, graphs, or circuit diagrams, and representative data.
c. Inspection (I) - Verification by visual examination of an item, or reviewing descriptive documentation, and comparing the appropriate characteristics with predetermined standards to determine conformance to requirements without the use of special laboratory equipment or procedures.
d. Demonstration (D) – Verification by operation, adjustment, or reconfiguration of items performing their designed functions under specific scenarios. The items may be instrumented and quantitative limits or performance monitored, but only check sheets rather than actual performance data are required to be recorded.

3.1.4 Tools (Verification Database).

The verification tracking process for SAR will be automated by the use of a database. The database will include all of the requirements to be verified and traceability to the requirements from which they flowed. This information will aid the verification activities by providing a single resource with which to track the flow down and interrelationships of the requirements; reviewing the status of planned and current verification activities; recording the results of verifications and generating reports for the design team, the customer organization, and any other valid user or recipient of this information.

3.2 Verification planning.

3.2.1.1 Allocation of requirements.

The largest portion of the planning activity is structuring and populating the Verification Database using the Dynamic Object Oriented Requirements System (DOORS) computer program so it accurately and completely describes the requirements, the relationships between requirements (especially at different levels), and the activities to be accomplished in verifying the requirements. The verification team will determine which requirements in SSP 57000, section 4, and SSP 57010, Appendix A are applicable to each item of equipment and identify the activities necessary to demonstrate that each applicable requirement has been met. Safety requirements and requirements flowed down to lower level specifications will also be included in the database.

3.2.1.2 Verification Definition Sheets (VDS).

Within the database structure will be a report following the format described in SSP 57010 called a Verification Definition Sheet (VDS). The VDS's provide instructions, definitions, references, and guidelines for the verification activities associated with each requirement in the database. Each VDS is tailored to describe the steps involved in verifying a specific requirement. These sheets can be printed from the database as required before the individual verifications are accomplished. (Appendix A shows the VDS example.)

3.2.1.3 Verification implementation and reporting.

Implementation and reporting refers to all those activities undertaken by the FCF Project office to verify the requirements and record the results of those verifications.

3.2.1.3.1 Implementation.

The verification activities will be executed in accordance with the VDS's generated from the database as described above. The individual responsible for completing a given portion of the verification will have access to the required VDS and related background information. That person will be primarily responsible for ensuring the conditions of the VDS are followed and that all data generated is appropriately recorded. Since verifications will be accomplished at several hardware indenture levels, lower level verification results will be incorporated at the next higher level until verification at the level intended by the requirement is completed.

3.2.1.3.2 Reporting.

After the verification data is generated, it will be recorded in the Verification Database and in supplementary records as necessary to yield the same easy access to the interrelated information as during the planning process. Status reports and other data deliverables will be automatically generated from the database. Most reports will be one of two types. The first type will identify the subject hardware then provide requirements traceability, verification methods and status, and the individual(s) responsible for the verification activities. The second type will be a comprehensive report intended to close out a requirement, upon which a Certificate of Verification is issued. Because this information will be stored and accessed electronically, it offers unprecedented ease of access to remote users and facilitates timely coordination of information in preparation for verification status, safety, and integration reviews. All data and reports generated as part of the verification process will be retained for the life of the FCF System, primarily in electronic format within the Verification Database. Examples of the verification certificates are given in Appendix B.

3.3 Certificate of verification.

As the verification activities are completed, the FCF Project office, or its assignees, will generate signed statements indicating that all of the requirements and verifications of ISS compatibility, functionality, and safety have been met. The Certification of Flight Readiness (CoFR) will be generated in compliance with the specific requirements of SSP 52054.

3.4 Maintenance of the Certificate of Verification.

Any changes to the SAR occurring after the verification activities are completed will be reviewed to assess their impacts on the individual requirements and their associated verification certificates. If such a review determines that reverification is warranted, the changes to the SAR and the proposed, additional verification activities will be presented to the ISS Payload Program Office for concurrence before the verification activities are completed.

3.5 Special verifications.

3.5.1 Flight safety requirements verification.

Safety requirements, which require formal verification, are contained in the FCF rack hazard reports approved by the Payload Safety Review Panel (PSRP). These requirements and their verifications will be included in the Verification Database. Traceability between the safety and ISS requirements will be maintained. Reports associated with these requirements will be provided to the PSRP. A safety verification tracking log generated from the database will allow open items to be tracked past the phase III review.

3.5.2 Science requirements verification.

SAR science requirements relating to FCF from FCF-DOC-002 will be included in the database to show the SAR science-related verifications meet requirements.

3.5.3 SAR payload verification.

The Sub-Rack Payloads used in SAR will be controlled by individual Interface Control Documents (ICD). Requirements imposed on such payloads will be verified though appropriate tests, analyses, inspections, and demonstrations by the payload organization and supplied to the FCF Project. The results will be combined with the verifications in the FCF Verification Database to ensure all ISS requirements are maintained while the Sub-Rack Payload is on and en route to the ISS. The SAR ability to integrate or re-verify the Sub-Rack Payload interface verifications will be verified on the original flight system, or use the Ground Integration Unit using a generic Sub-Rack Payload verification plan.

3.5.4 Carrier unique verification.

No carrier other than the Multi-Purpose Logistics Module (MPLM) has been identified.

3.5.5 GRC facility verifications.

The hardware and software used at GRC must meet the requirements of TM104438. Required verifications will be performed and the results supplied to the area safety committee to verify the requirements have been met.

3.5.6 KSC facility verifications.

The FCF and ground support equipment operated at Kennedy Space Center (KSC) will meet the KSC facility requirements. The verifications required by the Ground Safety Review Panel (GSRP) and verifications of the requirements in hazard reports approved by the GSRP will be completed. Associated reports will be provided to the GSRP for closure.

3.6 Staffing.

The specialties involved in FCF Verification are as follows:

1. Lead Systems Engineer
2. Systems Engineering Support Personnel
3. Database Administrators
4. Products Assurance Representative (PAR)
5. Electromagnetic Interference (EMI) Specialists
6. Structural Dynamic Measurements and Testing Specialists
7. Acoustical Noise Specialists
8. Microgravity Effects Specialists
9. Thermal Test Specialists
10. FCF Hardware Engineering Support Personnel
11. FCF Software Engineering Support Personnel
12. Toxicity/Offgas Specialists
13. Mechanical Technicians
14. Electrical Technicians

3.6.1 Personnel roles and responsibilities.

The Lead Systems Engineer is in charge of all FCF systems engineering activities. The Lead Systems Engineer monitors the project to insure that all components come together for the FCF System and that all hardware meets all functional and mission requirements and maintains all project documentation. The Lead Systems Engineer reports to the FCF Director.

The systems engineering support personnel are responsible for preparing and implementing all FCF requirement and verification documentation. The system engineering support personnel will implement this plan and oversee or perform all verifications. These individuals will prepare or monitor the preparation of all verification reports. The systems engineering support personnel report to the Lead Systems Engineer.

The database administrators set up the database required to monitor requirements and verifications as given in the MRDOC contract. The database administrators control access to the database and are the only personnel authorized to enter or edit information within the database. The database administrators report to the Lead Systems Engineer.

The PAR is an observer from the Quality Assurance group and is responsible for reviewing and insuring the FCF Verification Plan and its associated procedures are followed and conform to the FCF Product Assurance Plan.

EMI specialists oversee or perform the setup, testing, and report preparation of all FCF hardware that requires EMI tests to meet project requirements per FCF-PLN-0027.

The structural dynamic measurement and testing specialists are responsible for overseeing or performing the setup, testing, and report preparation of all FCF hardware that requires tests to meet project requirements per FCF-PLN-0053.

Acoustical noise specialists oversee or perform the setup, testing, and report preparation of all FCF hardware that requires acoustical noise testing per FCF-PLN-0023.

Microgravity control specialists oversee or perform the setup, testing, and report preparation of all FCF hardware that requires testing to verify conformance to microgravity requirements per FCF-PLN-0037.

Thermal test specialists oversee or perform the setup, testing, and report preparation of all FCF hardware that requires testing to verify conformance to thermal requirements per FCF-DOC-0016.

FCF hardware and software engineers provide required support for all verification activities.

Offgas/toxicity specialists oversee or perform the setup, testing, and report preparation of all FCF hardware that requires toxicity/offgas testing per NASA-STD-6000.

Mechanical and electrical technicians are used to support setup and breakdown of hardware for verification testing.

3.7 Verification test philosophy.

3.7.1 Rack verification philosophy.

The SAR is the last increment and will be verified at the rack level for all requirements. Certain qualification tests may be performed using the Engineering Model (EM). The vast majority of the performance, safety, and ISS interface verifications will be performed on the actual flight hardware. The Payload Rack Checkout Unit will be used to simulate ISS interfaces. A setup simulating the SAR will be used to verify SAR interface requirements.

Final verification of the SAR will involve use of the CIR and FIR GIU. Once the SAR is launched, the SAR GIU will be used for final verification of experiments.

3.7.2 Facility level qualification/verification analysis/test plans.

Project and ISS requirements impose requirements to develop plans that demonstrate compliance to reliability and the on-orbit environment. The plans are: acoustic control, electromagnetic interference/compatibility, mass properties, microgravity control, thermal testing, and structural design/verification. A summary of each report is given below.

3.7.2.1 Acoustic control.

The acoustic control process begins by defining the noise requirements set by the SSP 57000 Revision E (See Figure 5). Then an initial assessment is made for each of the noise-contributing components. These components are then integrated into a rack and an estimated rack noise level is determined. The components are then evaluated to determine the sound level needed to meet the rack level requirements. The design is then modified to meet the new component noise levels. An acoustic test is then performed on the rack to determine if it meets the SSP 57000 requirements. If it does not meet the requirements, a diagnostic test is performed to determine the source of the noise. Noise attenuation techniques are then investigated and another acoustic noise test is performed and the design is modified. Again a rack level acoustic test is performed to determine if the rack meets the SSP 57000 requirements. This cycle continues until these requirements are met, and when they are a final design is established. An integrated acoustical test is then performed on the rack and the verification process is complete. Detailed information is given in FCF-PLN-0023.

3.7.2.2 Electromagnetic interference/compatibility.

EMI/Electromagnetic compatibility (EMC) verification will be accomplished in two phases (See Figure 6). The first phase will include testing at the subsystem and box level per FCF-PLN-0027. This testing will involve both emissions and susceptibility testing of hardware drawing power from the Electrical Power Control Unit (EPCU) 28 Vdc and 120 Vdc supplies. Test requirements defined in FCF-PLN-0027 will also be used to test and evaluate on-orbit replacement hardware and future additional new hardware. Any out-of-limit measurements will be evaluated to determine if rack level configurations will provide additional shielding/filtering before redesign efforts are undertaken.

The second phase will involve full rack level testing per the requirements of SSP 57000.

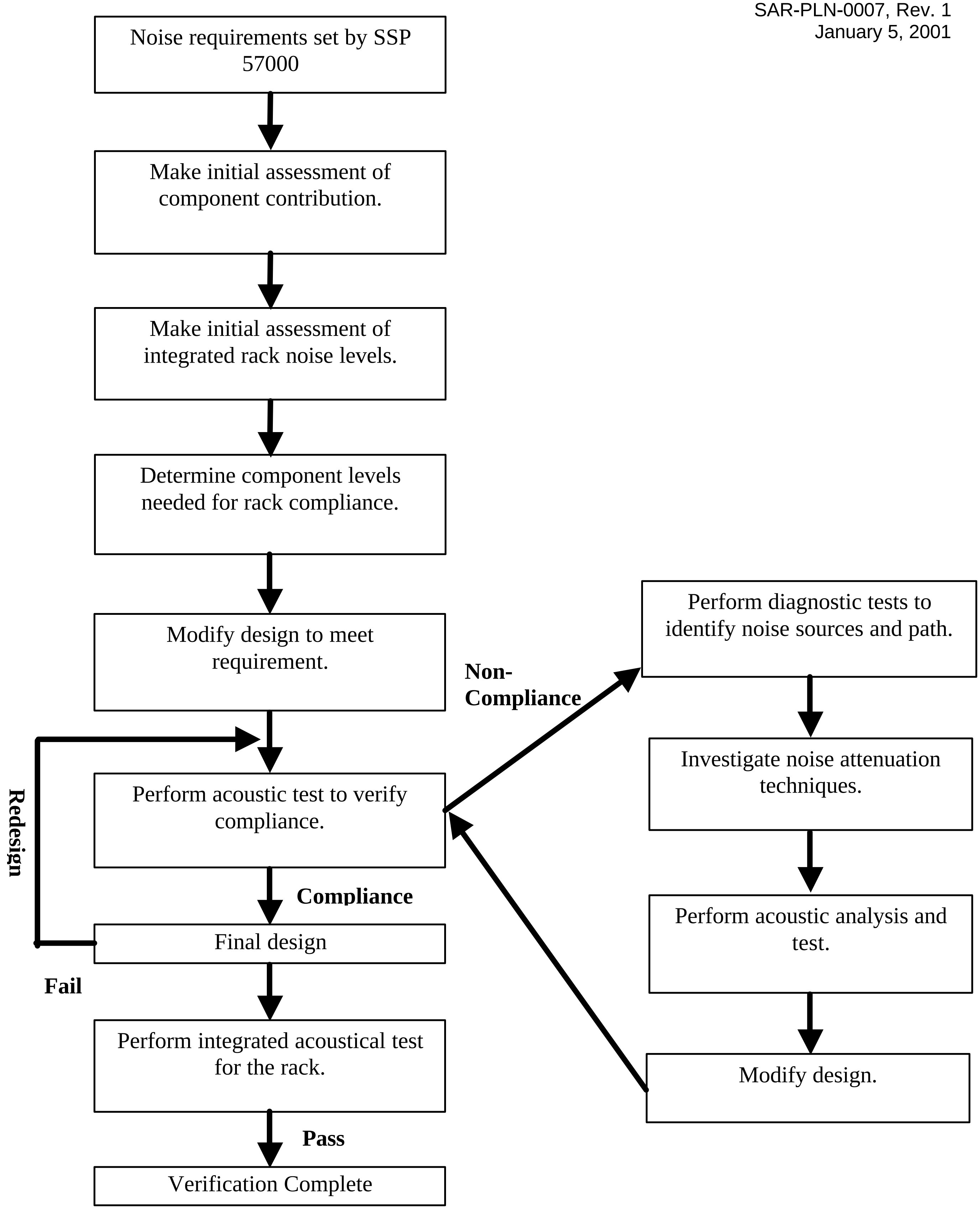


FIGURE 5. Acoustic control plan flow

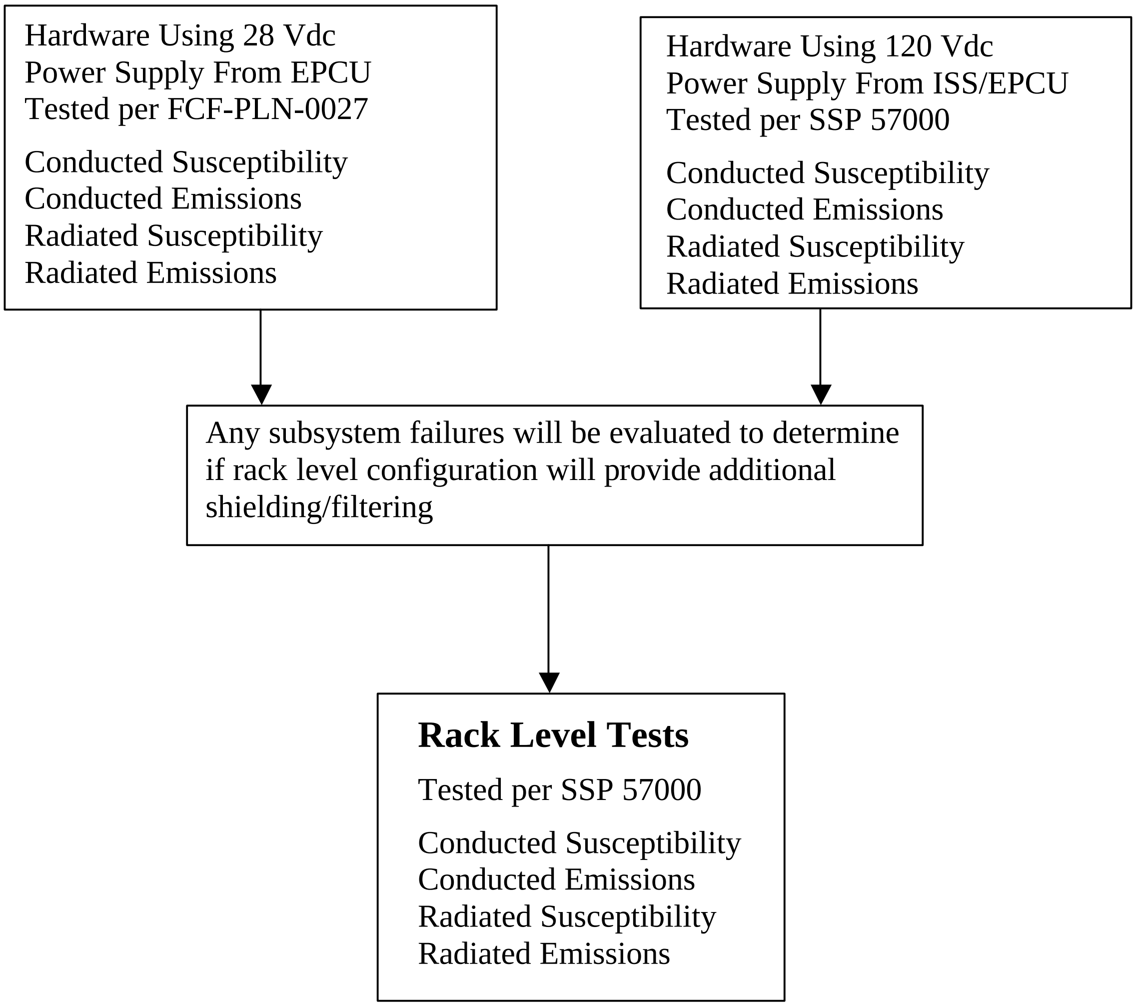


FIGURE 6. Electromagnetic interference/compatibility subsystem/box level tests including on-orbit replacement

3.7.2.3 Mass properties.

The process begins with the collection of all the mass properties data available from each of the project teams. This data is reported to the Rack Mass Managers electronically, who then submit the data to the Mass Properties Manager. FCF-RPT-0061 is then updated by the Mass Properties Manager to reflect changes made to the mass properties. The Mass Properties Manager determines if the mass is within the specified limit. If it is within the limits, the process begins over again in three months. If not, the Mass Properties Manager determines ways to reduce the mass and reports these to the Project Leads and in three months the mass is re-evaluated (See Figure 7). See FCF-PLN-0034 for details on mass properties control.

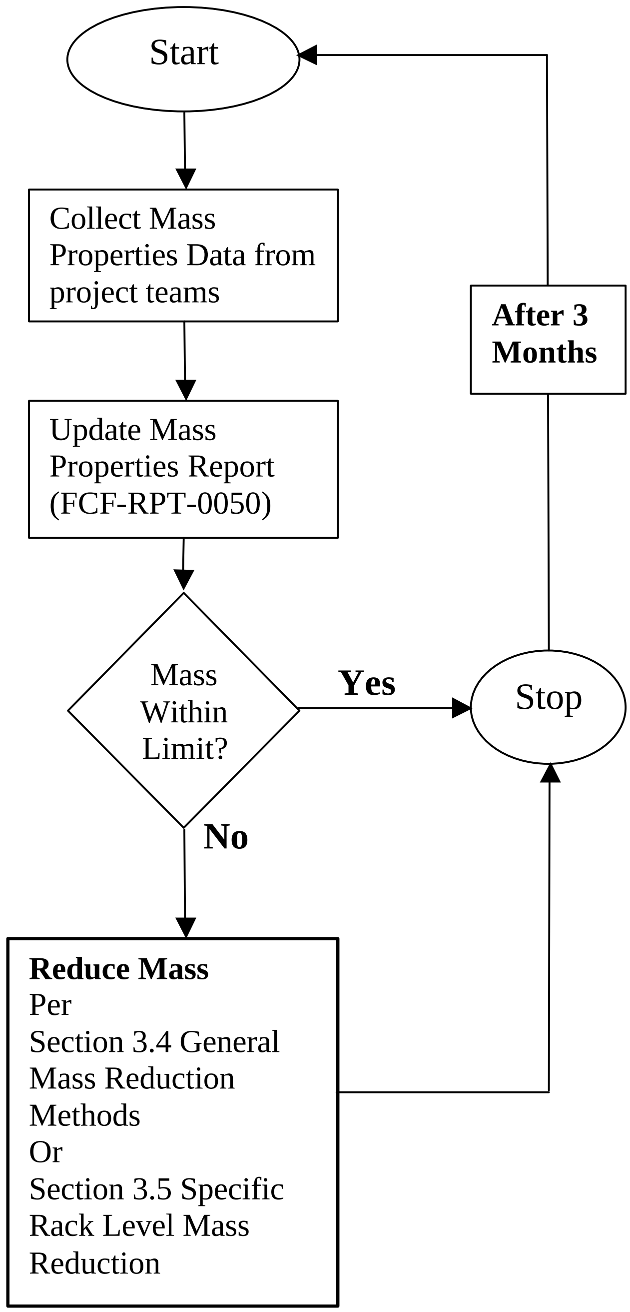


FIGURE 7. Mass properties plan flow

3.7.2.4 Microgravity control.

The process begins with the definition of the requirements. Then the wideband and narrowband functions are applied to develop a dynamic model of the rack and payload. This model is tested and compared to predicted data. Testing of the actual payload and new transfer functions and stiffness models are developed. A test of the actual rack is then performed, where possible, and tuned to meet the requirements. Different attenuation techniques are then examined and acceptable payload operating constraints are developed. The microgravity verification report is then developed and the process ends (See Figure 8). Detailed information is given in FCF-PLN-0037.

3.7.2.5 Thermal testing.

Thermal cycle testing is required to demonstrate that the experiment hardware will properly operate the experiment in its flight environment; properly control the thermal environment of temperature sensitive items with a passive or active thermal control system: and survive the temperature and humidity conditions of transportation, storage, and pre- and post-launch conditions on the carrier.

These tests shall also act as an environmental stress screen to stimulate latent defects to maximize infant mortality. This testing is required on components (packages) that fall under the criteria in Table I:

TABLE I. Thermal test criteria

Test	Electronic or Electrical Equipment	Antennas	Moving Mechanical Assembly	Solar Panel	Batteries	Fluid or Propulsion Equipment	Pressure Vessels	Thermal Equipment	Optical Equipment
Functional (1)	R	R	R	R	R	R	R	H	R
Thermal Cycling	R	R	.	R	-	R		R	R
Legend: R = Required (1) Functional tests shall be conducted prior and following environmental test									

There are two phases in the thermal cycle testing process. Phase I is thermal cycling at qualification test levels. This phase will be conducted using EM hardware. If duplicate components exist, only one must be tested. Functional testing must be performed during the first and last thermal cycles. The test format is shown in Figure 9.

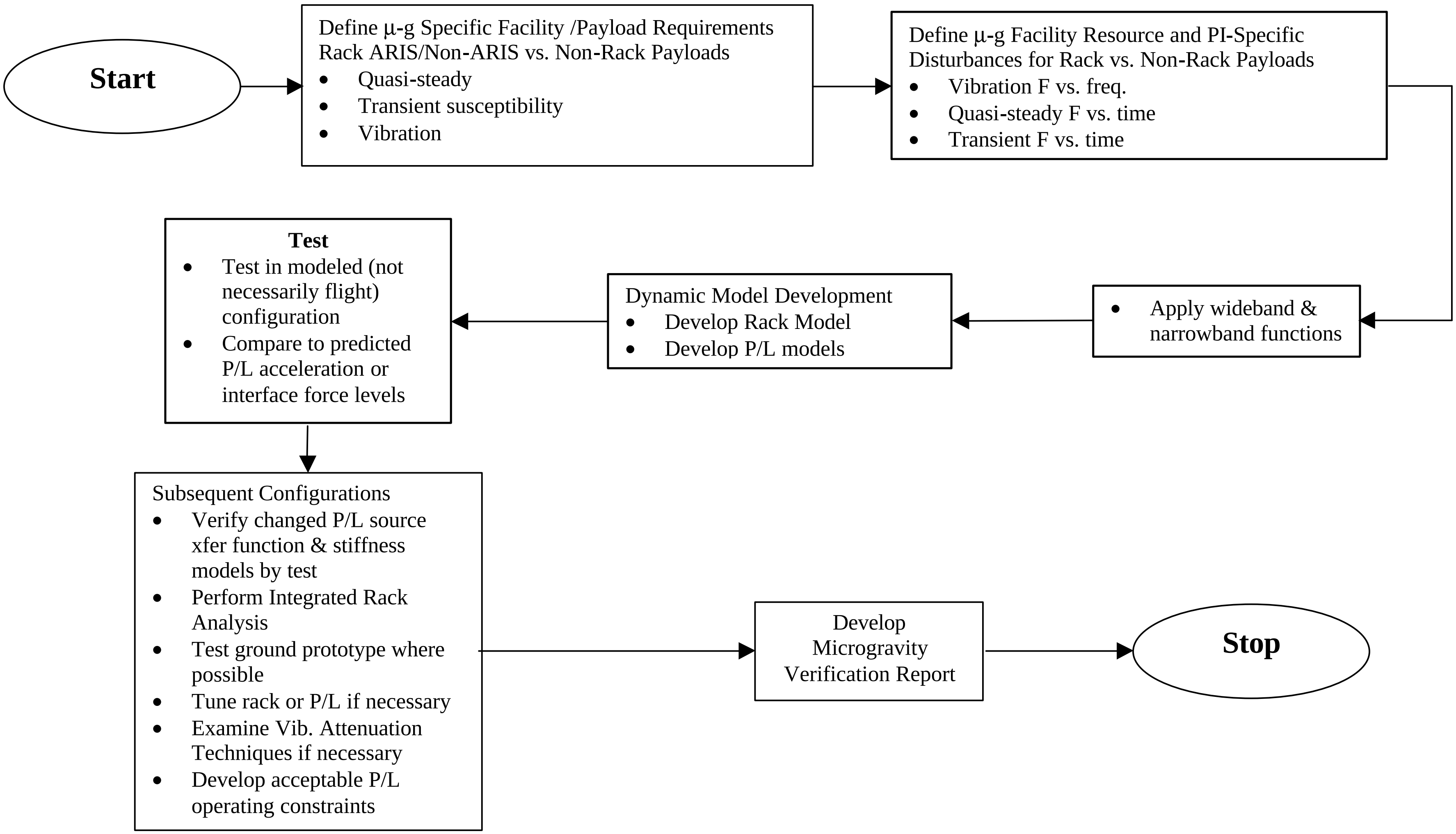


FIGURE 8. Microgravity verification flow

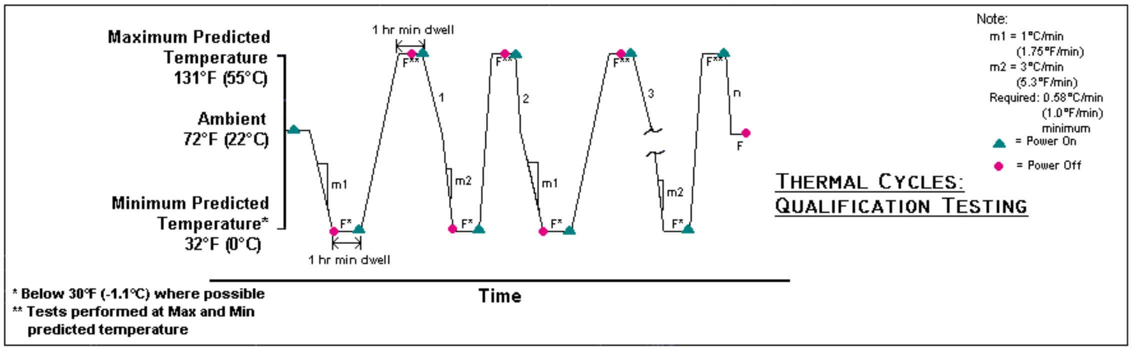


FIGURE 9. Functional thermal test format

Phase II is thermal cycling at acceptance levels and will be performed on all flight hardware (including duplicates), spares, GIU, and EDU components. Functional testing is required during the first and last cycles and a burn-in test will be conducted upon completion of the last thermal cycle. The general test format is shown in Figure 10.

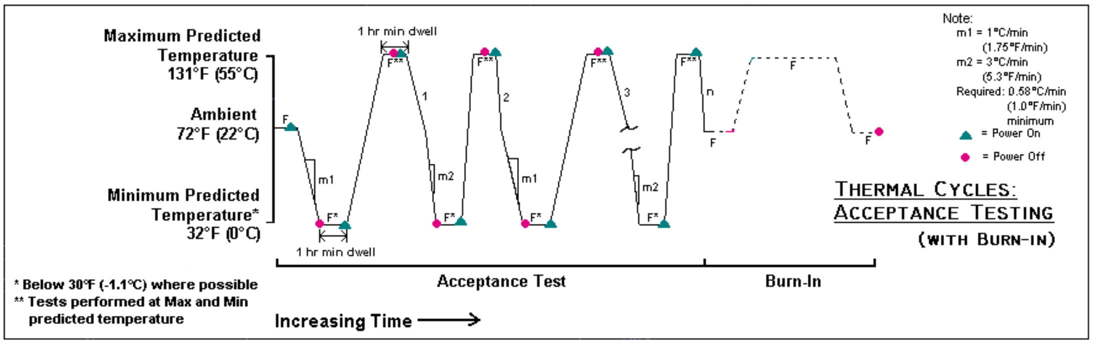


FIGURE 10. General thermal test format

Tailoring methods will be implemented throughout all testing when temperature extremes extend past the component's allowable operating and materials limits. A protoflight test program can be invoked on a per package basis if an extensive redesign is needed after qualification testing has been completed.

The thermal testing flow is given in Figure 11. Detailed explanations of the testing and retesting plans can be found in FCF-DOC-0016.

3.7.2.6 Structural design/verification.

Random vibration testing of space flight hardware is conducted for several reasons. The first is to ensure that the hardware will survive the launch environment without damage. Tests are critical for high frequency sensitive equipment because the complexity of design details of such hardware seriously limits the use of analysis. A dedicated unit or prototype is subjected to the

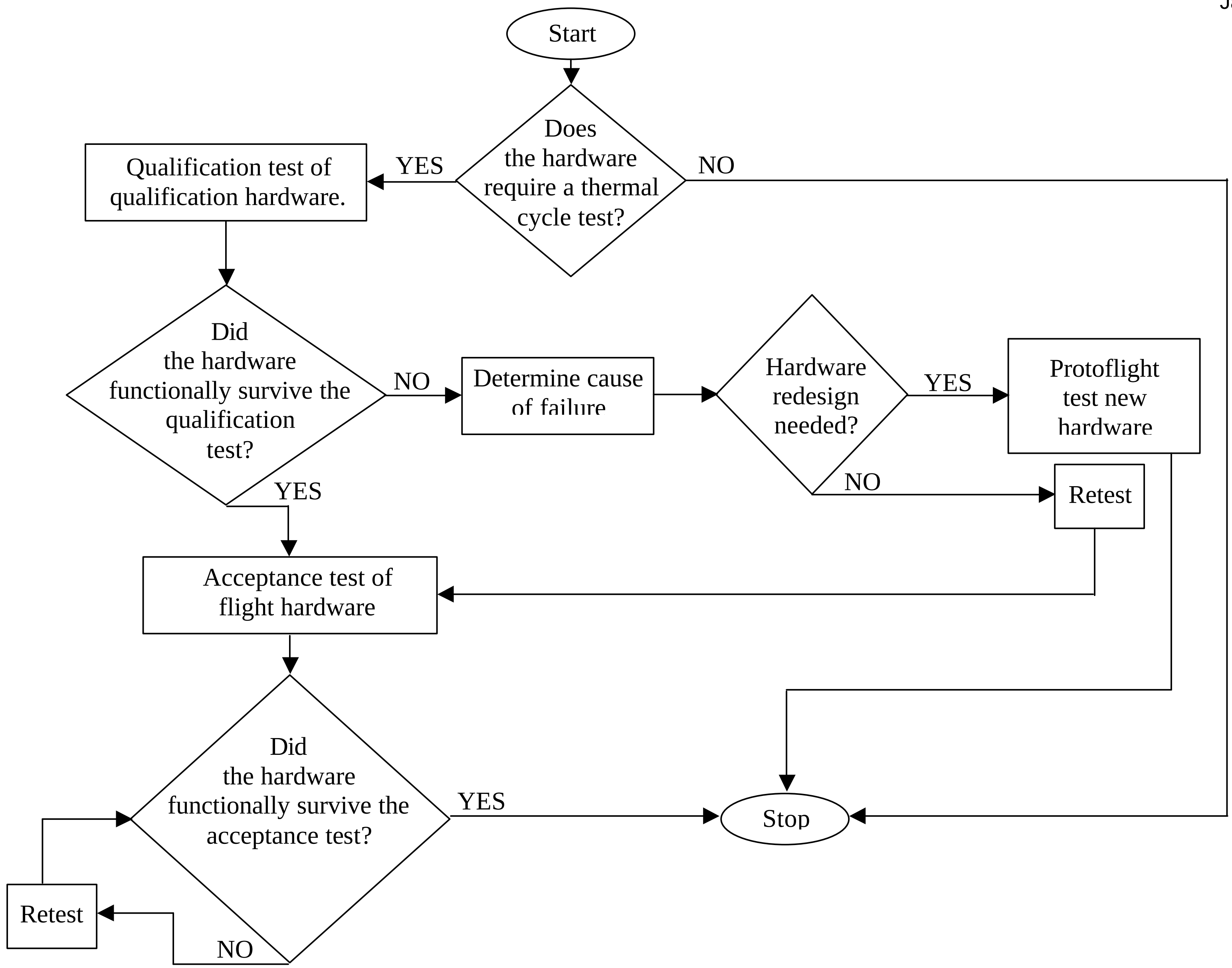


FIGURE 11. Thermal testing flow

expected flight level plus margin in both magnitude and duration. This test demonstrates the design adequacy of the hardware for its intended mission. Hardware that passes this test is considered “qualified” for flight, but it is never intended to fly.

Flight hardware of a previously qualified design is subjected to acceptance level testing. Acceptance tests are conducted to demonstrate satisfactory performance of flight systems relative to the expected environment and to reveal inadequacies in workmanship and material integrity. Acceptance tests are conducted at a magnitude below maximum expected flight level and for a reduced duration to avoid excessive use of hardware fatigue life.

Workmanship random vibration testing is performed to identify latent defects and manufacturing flaws in electronic, electrical, and electromechanical hardware at the component level. This kind of testing is combined with thermal cycling in a process called environmental stress screening.

Figure 12 presents a chart that describes the flow for vibration testing at the component level. Some FCF components will be stowed for shuttle launch and packed in material that will significantly attenuate the launch vibration environment. However, most of this hardware will still be subjected to the workmanship environment.

Figure 13 presents the flow for vibration testing at the subsystem level. Here, a subsystem is defined as hardware that has a direct interface with the rack posts. The test environment depends on the weight of the subsystem. Heavier subsystems are tested to a lower environment. Vibration sensitive components may be removed from subsystems before conducting the test. Vibration sensitive components need to be tested in the stowed configuration to the stowed environment. Detailed information can be found in FCF-PLN-0053.

3.7.2.7 SAR on-orbit verification.

On orbit verification will be performed on the SAR. These verifications will be done after the rack is installed and before setup for the first experiment. The verifications will be automated and ground commanded sequences that in some cases require test support equipment to be installed in the racks. This test support equipment may include standards (e.g., thermocouples, pressure transducers) and items, which produce “dummy” signals (e.g., a set resistor may act as an ignitor/heater or a circuit may provide canned data as a reply to a command).

The items chosen for on-orbit verification will be determined by 1) specific requirements for on-orbit verification, 2) particular needs, such as launch sensitive items, 3) critical functions, 4) safety driven requirements for test, and 5) recalibration needs. These will be indicated in the specific package verification sections.

The Input/Output Processor (IOP) will have a build in routine that it runs through upon boot up each time. This routine is called Power On Self Test (POST). This test will check the IOP itself and interfaces.

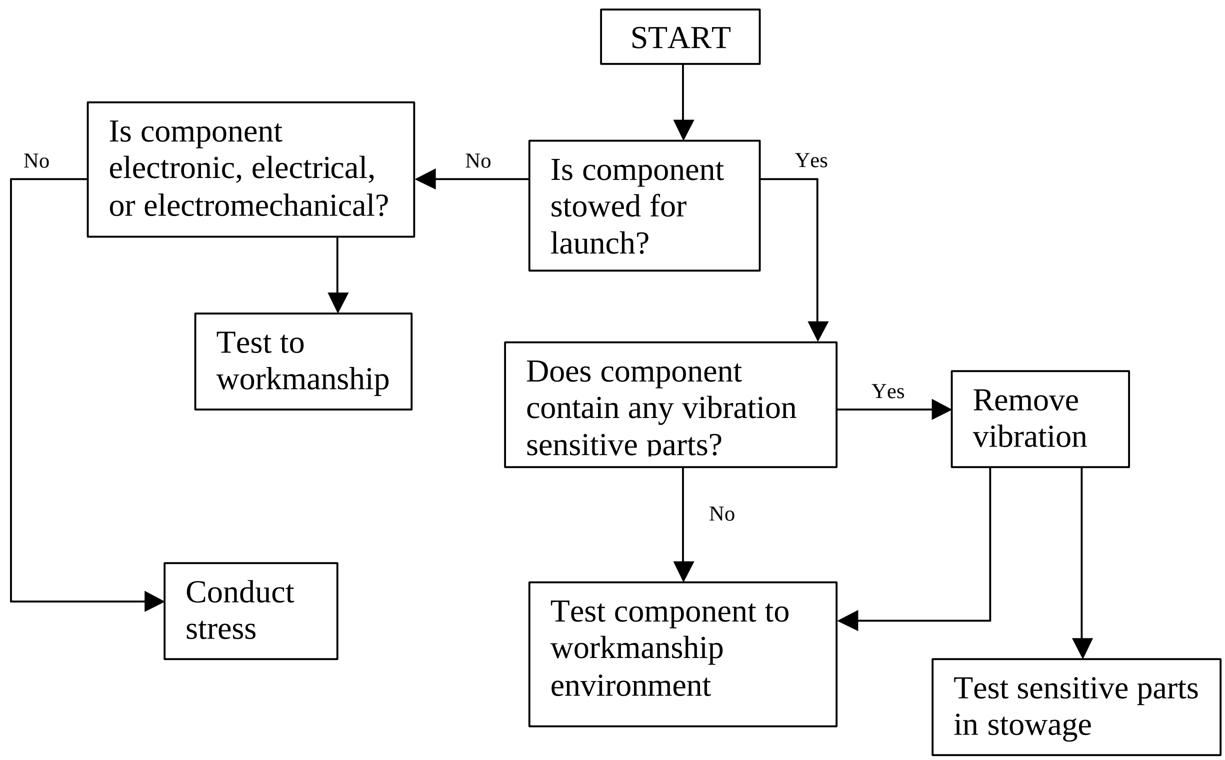


FIGURE 12. FCF component random vibration testing

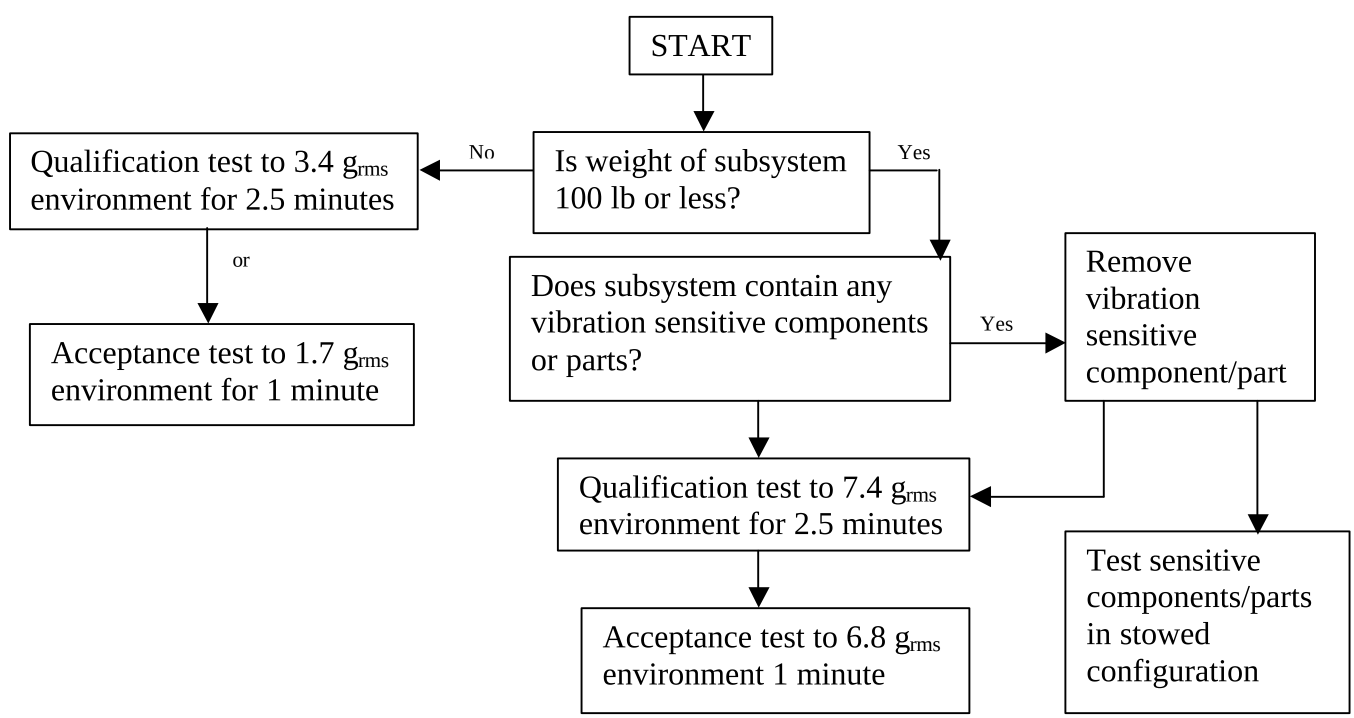


FIGURE 13. FCF subsystem random vibration testing

4.0 VERIFICATION REQUIREMENTS

This section identifies the verifications and methods to verify the SAR per FCF-SPC-0004. The VDS's, located in Appendix F, associated with this section contain additional information for specific verifications.

4.1 Performance characteristics.

Verification that the SAR meets the performance characteristics requirements as specified herein FCF-SPC-0001 shall be by inspection. Verification shall be considered successful when the inspection shows that the verifications as specified herein meet the performance characteristics requirements as specified herein from the requirements FCF-SPC-0001.

4.1.1 Utilization.

The SAR capability support science data collection and data transmission through the ISS to the ground when required, as specified in FCF-DOC-002 shall be verified by analysis. The verification shall be considered successful when the analysis shows the SAR capability support science data collection and data transmission through the ISS to the ground when required, as specified in FCF-DOC-002.

4.1.2 Support other ISS/payload systems.

The SAR capability of providing data acquisition and control services to other ISS systems and non-FCF payloads by allowing them to connect, on a noninterference basis, to the SAR avionics systems that are necessary to accomplish combustion science, fluids science and processing and providing data as specified in user interface agreement shall be verified by demonstration and test. The demonstration verification is considered successful when the demonstration shows that the SAR interfaces with the other ISS systems or non-FCF payloads. The test verification shall be considered successful when the tests show the SAR capability of providing data acquisition and control services to other ISS systems and non-FCF payloads by allowing them to connect, on a noninterference basis, to the SAR avionics systems that are necessary to accomplish combustion science, fluids science and processing and providing data as specified in user interface agreement. Analysis shall be used for any verifications that cannot be met by demonstration and test due to microgravity constraints.

4.1.3 Science volume.

The SAR capability to provide on-orbit, a volume in which payload equipment can be operated and investigations performed, that is reconfigurable within the envelope of 939.8 mm. x 515.0 mm. x 636.58 mm. (37 in. x 20.275 in. x 25.062 in.) shall be verified by analysis and demonstration. The analysis verification shall be considered successful when the analysis shows the SAR capability to provide on-orbit, a volume in which payload equipment can be operated and investigations performed, that is reconfigurable within the envelope of 939.8 mm. x 515.0 mm. x 636.58 mm. (37 in. x 20.275 in. x 25.062 in.), including the mounting of two double Middeck lockers or four single Middeck lockers. The demonstration verification shall be considered successful when the demonstration using potential PI mock-up shows the SAR capability to provide on-orbit, a volume in which payload equipment can be operated and investigations performed, that is reconfigurable within the envelope of 939.8 mm. x 546.1 mm. x 636.58 mm. (37 in. x 21.882 in. x 25.062 in.), including the mounting of two double Middeck lockers or four single Middeck lockers.

4.1.4 Science volume temperature.

The SAR capability to provide an ambient temperature between 20°C and 45°C within the science volume shall be verified by test. The verification shall be considered successful when the test shows the SAR capability to provide an ambient temperature between 20°C and 45°C within the science volume.

4.1.5 Science acceleration and vibration.

The SAR capability to maintain an acceleration and vibration environment as shown in during the operation shall be verified by analysis. The verification shall be successful when the analysis shows the SAR capability to maintain an acceleration and vibration environment as shown in Figure 14 during the operation.

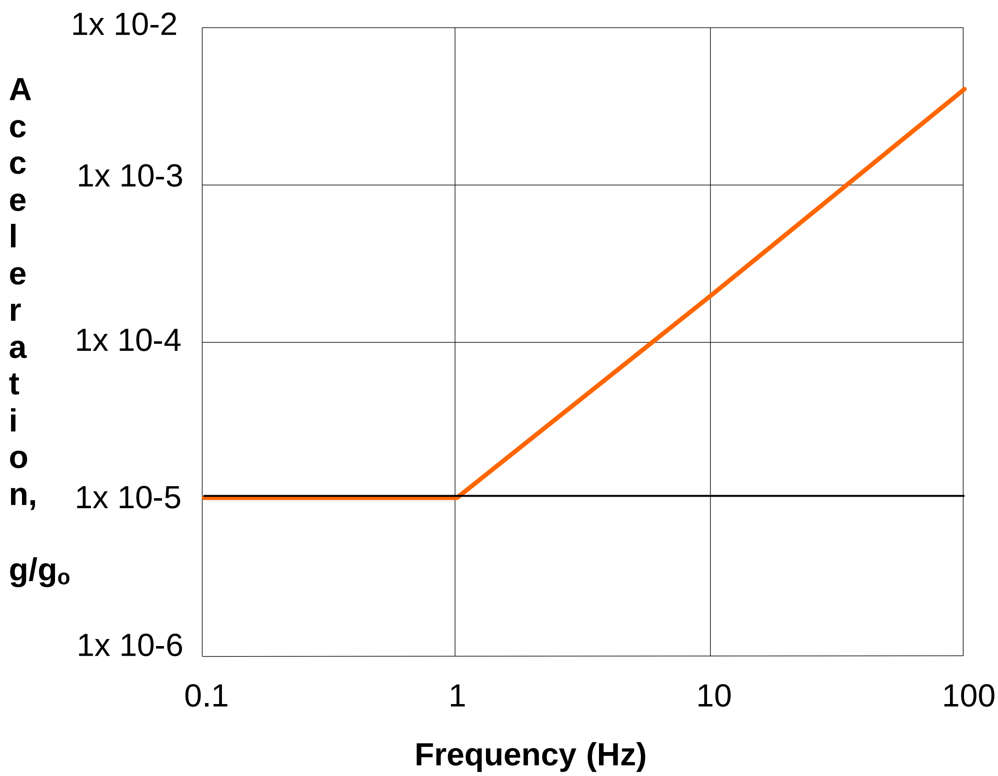


FIGURE 14. Acceptable minimum SAR acceleration and vibration levels

4.1.6 Internal data transmission.

a. The SAR capability of receiving data from experiments and equipment located within the science volume via two RS422 interfaces, eight analog interfaces (-5 volts (V) to +5 V differential (balanced) signals with a selectable sampling rate of 1, 10, or 100 Hz; however, all are sampled at the same rate and a resolution of 12bits) and twelve bi-directional discretes ("zero" at -0.5 to +2.0 VDC and "one" at +2.5 to +6.0 VDC single ended with a selectable sampling rate of 1 or 10 Hz; however, all are sampled at the same rate) shall be verified by test. The verification shall be considered successful when the test shows the SAR capability of receiving data from experiments and equipment located within the science volume via two RS422 interfaces, eight analog interfaces (-5 volts (V) to +5 V differential (balanced) signals with a selectable sampling rate of 1, 10, or 100 Hz; however, all are sampled at the same rate and a resolution of 12bits) and twelve bi-directional discretes ("zero" at -0.5 to +2.0 VDC and "one" at +2.5 to +6.0 VDC single ended with a selectable sampling rate of 1 or 10 Hz; however, all are sampled at the same rate).
b. The SAR capability of providing two connections to an Ethernet communications bus for acquiring data from and controlling the equipment within the science volume shall be verified by inspection. The verification shall be considered successful when the inspection shows the SAR capability of providing two connections to an Ethernet communications bus for acquiring data from and controlling the equipment within the science volume.
c. The Ethernet connections configurable to either 10baseT or 100baseT shall be verified by analysis. The verification shall be considered successful when the analysis shows the Ethernet connections configurable to either 10baseT or 100baseT.
d. The SAR capability of providing two RS170A video interfaces to receive video signals from the equipment within the science volume shall be verified by inspection. The verification shall be considered successful when the inspection shows the SAR capability of providing two RS170A video interfaces to receive video signals from the equipment within the science volume.
e. The SAR capability for the equipment within the science volume to connect to image processing storage systems provided within the SAR to acquire CIR and FIR digital video streams, if they are not in use by the CIR or FIR shall be verified by demonstration. The verification shall be considered successful when the demonstration shows the SAR capability for the equipment within the science volume to connect to image processing storage systems provided within the SAR to acquire CIR and FIR digital video streams, if they are not in use by the CIR or FIR.
f. The SAR control of the equipment placed within the science volume via the Ethernet and bi-directional discrete interfaces shall be verified by test. The verification shall be considered successful when the test shows the SAR control of the equipment placed within the science volume via the Ethernet and bi-directional discrete interfaces.
g. The SAR capability of providing two connections to a 1553B communications bus for commanding and controlling the equipment within the science volume shall be verified by inspection. The verification shall be considered successful when the inspection shows the SAR capability of providing two connections to a 1553B communications bus for commanding and controlling the equipment within the science volume.

4.1.7 Data time reference.

The SAR capability, with applicable PI hardware, to reference all data, including digital images, to ISS-related mission time shall be verified by test. Verification shall be considered successful when the test shows the SAR, with applicable PI hardware, can reference all data, including digital images, to ISS-related mission time.

4.1.7.1 Data time reference for experiment events.

The SAR capability, with applicable PI hardware, to have a time reference resolution of ± 0.001 s for experiment events shall be verified by test. Verification shall be considered successful when the test shows the SAR, with applicable PI hardware, can have a time reference resolution of ± 0.001 s for experiment events.

4.1.7.2 Data time reference for external events.

The SAR capability, with applicable PI hardware, to have a time reference resolution of ± 1 s for external events shall be verified by test. Verification shall be considered successful when the test shows the SAR, with applicable PI hardware, can have a time reference resolution of ± 1 s for external events.

4.1.8 SAR multiple experiment operations.

The SAR not precluding operation of multiple simultaneous experiments within its rack shall be verified by analysis. The verification shall be considered successful when the analysis shows the SAR not precluding operation of multiple simultaneous experiments within its rack.

4.1.9 On-orbit instrument calibration.

The SAR capability to perform on orbit calibrations of instruments using standards traceable to the NIST shall be verified by test. Verification shall be considered successful when the test shows the SAR can perform on orbit calibrations of instruments using standards traceable to the NIST.

4.1.9.1 Replacement of on-orbit instruments.

The SAR capability to replace instruments not capable of being calibrated on orbit with instruments calibrated to standards traceable to NIST shall be verified by demonstration. Verification shall be considered successful when the demonstration shows the SAR can replace instruments not capable of being calibrated on orbit with instruments calibrated to standards traceable to NIST.

4.1.10 Rack environment monitoring.

The SAR capability to monitor the pressure, temperature, humidity, and acceleration within the SAR rack environment shall be verified by analysis and test. Analysis verification shall be considered successful when the analysis shows the SAR can measure pressure and humidity from the U.S. Lab environment and correlate the measurements to the SAR rack environment. Test verification shall be considered successful when the test shows the SAR can measure SAR rack temperature and acceleration environments using SAMS Free Flyer and temperature sensors in various locations throughout the SAR rack.

4.1.11 On-orbit data collection and transfer.

4.1.11.1 Processing and providing data.

a. SAR capability of interfacing with the ISS to allow all on orbit data transfer for downlinking to the ground for use by the payload equipment and FCF ground crews and for data archiving shall be verified by test and inspection. The verification shall be considered successful when the test shows the SAR capability of interfacing with the ISS to allow all on orbit data transfer for downlinking to the ground for use by the payload equipment and FCF ground crews and for data archiving and the inspection shows that all data properly transferred.
b. The SAR design to accept acquired, synthesized, and transfer science performance, configuration, status assessment, and message data from the CIR and/or FIR shall be verified by test using the CIR and FIR GIU's. The verification shall be considered successful when the test shows the SAR design to accept acquired, synthesized, and transfer science performance, configuration, status assessment, and message data from the CIR and/or FIR.
c. The SAR capability to acquire, synthesize and present science, performance, configuration, status assessment, and message data to the on orbit crew in the form of textual and graphic displays to the SSC shall be verified by test. The verification shall be considered successful when the test shows the SAR capability to acquire, synthesize and present science, performance, configuration, status assessment, and message data to the on orbit crew in the form of textual and graphic displays to the SSC.
d. The SAR capability of processing scientific and engineering data in order to reduce the real-time, near real-time and post test bandwidth and duration necessary to transmit the data to the ground through the ISS as described in FCF-SPC-0004, paragraph 3.2.1.11.1 d shall be verified by test. The verification shall be considered successful when the test shows the SAR capability of processing scientific and engineering data in order to reduce the real-time, near real-time and post test bandwidth and duration necessary to transmit the data to the ground through the ISS as described in FCF-SPC-0004, paragraph 3.2.1.11.1 d.
e. The SAR capability of running payload equipment software code to process raw imaging and sensor data to extract quantitative data and information of interest and/or to perform data compression shall be verified by test. The verification shall be considered successful when the test shows the SAR capability of running payload equipment software code to process raw imaging and sensor data to extract quantitative data and information of interest and/or to perform data compression.
f. The SAR capability to retain all data until commands are received from the FCF ground operations team indicating what data can be deleted or overwritten shall be verified by test. The verification shall be considered successful when the test shows the SAR capability to retain all data until commands are received from the FCF ground operations team indicating what data can be deleted or overwritten.
g. The SAR capability of providing, when requested by the FCF ground operations team, a summary of all data stored in the SAR, including identification of each measurement, time stamp/duration of data for each measurement, and file sizes shall be verified by test. The

verification shall be considered successful when the test shows the SAR capability of providing, when requested by the FCF ground operations team, a summary of all data stored in the SAR, including identification of each measurement, time stamp/duration of data for each measurement, and file sizes.

h. The SAR capability of receiving eight imaging streams from scientific imaging devices in the CIR and/or FIR for image processing and storage shall be verified by demonstration using the CIR and FIR GIU's. The verification shall be considered successful when the demonstration shows SAR capability of receiving eight imaging streams from scientific imaging devices in the CIR and/or FIR for image processing and storage.

4.1.11.2 National television standards committee (NTSC) video.

a. The SAR capability of displaying NTSC quality video, from any video source or data file (containing video images) within the Flight Segment, on a dedicated device, for use by the on-orbit crew shall be verified by demonstration. The verification shall be considered successful when the demonstration shows the SAR capability of displaying NTSC quality video, from any video source or data file (containing video images) within the Flight Segment, on a dedicated device, for use by the on-orbit crew.
b. This device having as a minimum 32 bit color, 1024x768 resolution, 250 mm diagonal size shall be verified by inspection. The verification shall be considered successful when the inspection shows the device having as a minimum: 32 bit color, 1024x768 resolution, 250 mm diagonal size.
c. The video source being selectable by either the Ground Operations Team at the GRC TSC, or by the on-orbit crew shall be verified by test using simulated ground operations for the TSC. The verification shall be considered successful when the test shows the video source being selectable by either the Ground Operations Team at the GRC TSC, or by the on-orbit crew.

4.1.11.3 On-orbit data transfer within FCF.

The SAR capability of accepting and transferring all data to the SAR at a minimum rate of 100 Mbits/s shall be verified by test. The verification shall be considered successful when the test shows the SAR capability of accepting and transferring all data to the SAR at a minimum rate of 100 Mbits/s.

4.1.11.4 Use of fiber optics.

The SAR use of fiber optics for transferring all digital image data and inter-rack communications shall be verified by inspection. The verification shall be considered successful when the inspection shows the SAR use of fiber optics for transferring all digital image data and inter-rack communications.

4.1.11.5 On-orbit data transfer to portable media.

The SAR capability of transferring all stored data to portable media shall be verified by inspection and test. The test verification shall be considered successful when the test shows the SAR capability of transferring all stored data to portable media. The inspection verification shall be considered successful when the inspection shows all the data transferred intact.

4.1.12 SAR health status monitoring.

The SAR capability, with applicable PI hardware and software, to monitor and transfer on orbit health status data of all assemblies with electrical and fluids interfaces to the SCC and to transfer on orbit health status data to the ISS for downlinking when the SAR is powered and note any out-of-tolerance conditions shall be verified by test. Verification shall be considered successful when the test shows the SAR, with applicable PI hardware and software, can monitor and transfer on orbit health status data to the ISS for downlinking of all assemblies with electrical and fluids interfaces to the SCC and downlink on orbit health status data, noting any out-of-tolerance conditions, when the SAR is powered.

4.1.12.1 FCF health status monitoring.

The SAR capability to interface with the SCC, to transfer to the SCC health status data of FCF systems that interface with the SAR, and to transfer the health status data to the ISS for downlinking when the SAR is powered and note any out-of-tolerance conditions shall be verified by test. Verification shall be considered successful when the test shows the SAR can interface with the SCC, can transfer to the SCC health status data of FCF systems that interface with the SAR, and can transfer the health status data to the ISS, noting any out-of-tolerance conditions for downlinking when the SAR is powered.

4.1.12.2 SAR/ISS health status monitoring.

The SAR capability to interface with the SCC, to transfer to the SCC its health status data of ISS systems that interface with the SAR, and to transfer the health status data to ISS for downlinking when the SAR is powered, noting any out-of-tolerance conditions, shall be verified by test. Verification shall be considered successful when the test shows the SAR can interface with the SCC, can transfer to the SCC health status data of ISS systems that interface with the SAR, and can transfer the health status data to the ISS for downlinking, noting any out-of tolerance conditions, when the SAR is powered.

4.1.13 SAR Commanding.

4.1.13.1 SSC Commanding.

The SAR capability, with applicable PI hardware and software, to accept command inputs, acknowledge and validate the inputs, return responses, and monitor all SAR functions that use the SSC when the SAR is powered shall be verified by test. Verification shall be considered successful when the test shows the SAR, with applicable PI hardware and software, can accept command inputs, acknowledge and validate the inputs, return responses, and monitor all SAR functions that use the SSC when the SAR is powered.

4.1.13.2 Ground Commanding.

The SAR capability, with applicable PI hardware and software, to accept command inputs, to acknowledge and validate the inputs, and to return responses though the ISS-provided interfaces when the SAR is powered shall be verified by test. Verification shall be considered successful when the test shows the SAR, with applicable PI hardware and software, can accept command inputs, acknowledge and validate the inputs, and return responses though the ISS-provided interfaces when the SAR is powered.

4.1.13.3 Manual inputs.

The SAR capability to provide the mechanical (switches, displays, etc.) equipment necessary for the on orbit crew to control the SAR shall be verified by inspection. The verification shall be considered successful when the inspection shows the SAR capability to provide the mechanical (switches, displays, etc.) equipment necessary for the on orbit crew to control the SAR.

4.1.13.4 Commanding for problem propagation.

The SAR capability to command the CIR, FIR, and/or itself, as necessary, to prevent propagation of a problem in one rack to any other rack shall be verified by test using the CIR and FIR GIU's. The verification shall be considered successful when the test shows the SAR capability to command the CIR, FIR, and/or itself, as necessary, to prevent propagation of a problem in one rack to any other rack.

4.1.14 Upgrading of SAR maintenance items.

The SAR capability to allow for upgrading of components within the assemblies and other maintenance items within the SAR shall be verified by analysis. Verification shall be considered successful when the analysis shows the SAR can allow for upgrading of components within the assemblies and other maintenance items within the SAR.

4.1.15 SAR reconfiguration.

a. The SAR capability to support the reconfiguration necessary to support and accommodate payload equipment systems manifested in the SAR within the payload constraints as specified herein shall be verified by demonstration. The verification shall be considered successful when the demonstration shows the SAR capability to support the reconfiguration necessary to support and accommodate payload equipment systems manifested in the SAR within the payload constraints as specified herein.
b. The SAR capability of being reconfigured without impacting the operations of the FIR or CIR if the SAR is not supporting CIR or FIR operations, except for possible microgravity disturbances shall be verified by demonstration. The verification shall be considered successful when the demonstration shows the SAR capability of being reconfigured without impacting the operations of the FIR or CIR if the SAR is not supporting CIR or FIR operations, except for possible microgravity disturbances.
c. All planned SAR reconfiguration activities capable of being accomplished with the rack in its installed position shall be verified by demonstration. The verification shall be considered successful when the demonstration shows all planned SAR reconfiguration activities capable of being accomplished with the rack in its installed position.

4.1.16 Control the SAR.

a. The SAR capability to provide overall control as specified in Table II shall be verified by test. The verification shall be considered successful when the test shows the SAR capability to provide overall control as specified in Table II.
b. The SAR capability to control all payload equipment placed within the SAR shall be verified by test. The verification shall be considered successful when the test shows the SAR capability to control all payload equipment placed within the SAR.
c. The SAR capability to command the CIR and/or FIR when the CIR and/or FIR can delete or over-write data shall be verified by test using the CIR and FIR GIU. The verification shall be considered successful when the test shows the SAR capability to command the CIR and/or FIR when the CIR and/or FIR can delete or over-write data.
d. The SAR capability of controlling via RS232 serial and Discrete I/O, up to four imaging devices located in the CIR when it is acquiring imaging streams from them shall be verified by test using the CIR GIU. The verification shall be considered successful when the test shows the SAR capability of controlling via RS232 serial and Discrete I/O, up to four imaging devices located in the CIR when it is acquiring imaging streams from them.

TABLE II. Control conditions

Capability	Control Conditions
Perform/support combustion science	Capability is not required to be continuous. Initiation of capability shall be through ground or on-orbit crew command.
Process and provide data	Capability is not required to be continuous. Initiation of capability shall be through automated sequence or ground or on-orbit crew command.
Respond to out-of-tolerance conditions	Capability is required to be continuous, whenever powered.
Withstand external environment changes	Capability is required to be continuous.
Accept commanding and manual inputs	Capability is required to be continuous, whenever powered.
Maintenance/troubleshooting	Capability is not required to be continuous. Initiation of capability shall be through ground or on-orbit crew command or on-orbit crew operation.
Reconfigure SAR	Capability is not required to be continuous. Initiation of capability shall be through ground or on-orbit crew command for software and on-orbit crew operation for hardware.

4.2 Physical characteristics.

4.2.1 SAR dimensional characteristics.

4.2.1.1 SAR launch envelope.

The SAR in launch configuration not exceeding the envelope as specified in SSP 41017 Part 1, paragraph 3.2.1.1.2 shall be verified by analysis and test. Analysis verification shall be considered successful when the analysis shows using computer modeling tools and drawings that the SAR in launch configuration does not exceed the envelope as specified in SSP 41017 Part 1, paragraph 3.2.1.1.2. Test verification shall be considered successful when the test shows the SAR in launch configuration does not exceed the envelope as specified in SSP 41017 Part 1, paragraph 3.2.1.1.2.

4.2.1.2 SAR on-orbit envelope.

The SAR, with applicable PI hardware, having an on orbit envelope as specified in SSP 41017 Part 1, paragraph 3.2.1.1.2 and following the on orbit payload protrusion requirements as specified in SSP 57000, paragraph 3.1.1.7. shall be verified by analysis and test in accordance with SSP 57000 paragraph 4.3.1.1.7. Analysis verification shall be considered successful when the analysis, using computer modeling tools, shows the SAR, with applicable PI hardware, has an on orbit envelope as specified in SSP 41017 Part 1, paragraph 3.2.1.1.2 and follows the on orbit payload protrusion requirements as specified in SSP 57000, paragraph 3.1.1.7 drawings in accordance with SSP 57000, paragraph 4.3.1.1.7.Test verification shall be considered successful when the test shows the SAR, with applicable PI hardware, has an on orbit envelope as specified in SSP 41017 Part 1, paragraph 3.2.1.1.2 and follows the on orbit payload protrusion requirements as specified in SSP 57000, paragraph 3.1.1.7 in accordance with SSP 57000, paragraph 4.3.1.1.7.

4.2.1.3 SAR stowage volume.

The SAR not exceeding a maintenance item stowage volume of 0.25 m^3 shall be verified by analysis and test. Analysis verification shall be considered successful when the analysis, using computer modeling tools and drawings, shows the SAR does not exceed a stowage volume of 0.25 m^3. Test verification shall be considered successful when the test shows the SAR does not exceed a stowage volume of 0.25 m^3.

4.2.1.4 SAR maintenance item stowage.

The SAR maintenance items not exceeding an up-volume of 1/3 standard rack equivalents shall be verified by analysis and test. Analysis verification shall be considered successful when the analysis, using computer modeling tools and drawings, shows the SAR maintenance items do not exceed an up-volume of 1/3 standard rack equivalents. Test verification shall be considered successful when the test shows the SAR maintenance items do not exceed an up-volume of 1/3 standard rack equivalents.

4.2.2 SAR weight characteristics.

a. The SAR not exceeding a launch mass of 804.2 kg (1773 lbs), excluding stowage hardware, shall be verified by analysis and demonstration. Analysis verification shall be considered successful when the analysis, using computer modeling tools, shows the SAR does not exceed a launch mass of 804.2 kg (1773 lbs), excluding stowage hardware. Demonstration verification shall be considered successful when the demonstration, by weighing the actual hardware components and assemblies to within a total SAR of 2.3 kg (5 lbs), shows the SAR does not exceed a launch mass of 804.2 kg (1773 lbs).
b. The SAR, with applicable PI hardware, not exceeding an on orbit mass of 804.2 kg (1773 lbs) with a minimum science payload mass of 131 kg (288 lbs) around center of gravity ± 200 mm of the science payload volume specified in FCF-SPC-0004, paragraph 3.2.1.3, excluding stowage hardware, shall be verified by analysis and demonstration. Analysis verification shall be considered successful when the analysis, using computer modeling tools, shows the SAR, with applicable PI hardware, does not exceed an on orbit mass of 804.2 kg (1773 lbs) with a minimum payload mass of 131 kg (288 lbs) around center of gravity ± 200 mm of the science payload volume specified in FCF-SPC-0004, paragraph 3.2.1.3, excluding stowage hardware. Demonstration verification shall be considered successful when the demonstration, by weighing the actual hardware components and assemblies, shows the SAR, with applicable PI hardware, does not exceed an on orbit mass of 804.2 kg (1773 lbs), excluding stowage hardware.
c. SAR spares and resupply equipment not exceeding an up-mass of 125 kg (312.5 lbs) shall be verified by analysis and demonstration. Analysis verification shall be considered successful when the analysis, using computer modeling tools, shows the SAR spares and resupply equipment do not exceed an up-mass of 125 kg(312.5 lbs). Demonstration verification shall be considered successful when the demonstration, by weighing the actual hardware components and assemblies, shows the SAR spares and resupply equipment do not exceed an up-mass of 125 kg (312.5 lbs).

4.2.3 SAR power.

a. The SAR capability, with applicable PI hardware, to use a maximum of 6,000 W of power shall be verified by analysis. Verification shall be considered successful when the analysis shows the SAR, with applicable PI hardware, can use a maximum of 6,000 W of power.
b. The SAR capability, with applicable PI hardware, to be integrated into the FCF and not exceed a power draw of 2,000 W shall be verified by analysis. Verification shall be considered successful when the analysis shows the SAR, with applicable PI hardware, can be integrated into the FCF and not exceed a power draw of 2,000 W.

4.2.3.1 SAR environmental control system power allocation.

The SAR environmental control system power allocation, over a period of 30 minutes, not exceeding 30 W or 8% of the input power to the SAR, whichever is greater, shall be verified by analysis and test. Analysis verification shall be considered successful when the analysis shows the SAR environmental control system power allocation, over a period of 30 minutes, does not exceed 30 W or 8% of the input power to the SAR, whichever is greater. Test verification shall be considered successful when the test shows the SAR environmental control system power allocation, over a period of 30 minutes, does not exceed 30 W or 8% of the input power to the SAR, whichever is greater.

4.2.3.2 SAR power to PI equipment.

The SAR capability to provide a minimum of 8 channels of 4A, 28 Vdc power for PI avionics shall be verified by inspection and test. Inspection verification shall be considered successful when the inspection of the SAR drawings show the SAR can provide a minimum of 8 channels of 4A, 28 Vdc power for PI avionics. Test verification shall be considered successful when the test shows the SAR can provide a minimum of 8 channels of 4A, 28 Vdc power for PI avionics.

4.2.3.3 SAR power consumption during downlink.

The SAR capability to consume less than 500 W when only performing image processing and downlinking operations shall be verified by test. The verification shall be considered successful when the test shows the SAR capability to consume less than 500 W when only performing image processing and downlinking operations.

4.2.4 SAR heat rejection.

The SAR capability to reject a maximum of 6,000 W of power shall be verified by analysis. The verification shall be considered successful when the analysis shows the SAR can reject a maximum of 6,000 W of power.

4.2.5 SAR science heat rejection.

<TBD 04-01>

4.2.6 Thermal cooling water.

The SAR capability, with applicable PI hardware, to provide thermal water cooling with a minimum inlet temperature of 16.1°C (61.0°F) and a maximum outlet temperature of 48.9°C (120°F) shall be verified by analysis and test. Analysis verification shall be considered successful when the analysis shows the SAR, with applicable PI hardware, can provide thermal water cooling with a minimum inlet temperature of 16.1°C (61.0°F) and a maximum outlet temperature of 48.9°C (120°F). Test verification shall be considered successful when the test shows the SAR, with applicable PI hardware, can provide thermal water cooling with a minimum inlet temperature of 16.1°C (61.0°F) and a maximum outlet temperature of 48.9°C (120°F).

4.2.7 Durability.

a. The SAR design to have a minimum operational life of 10 years after full deployment of the FCF, including regularly scheduled and unscheduled maintenance activities, shall be verified by analysis. Verification shall be considered successful when the analysis shows the SAR is designed to have a minimum operational life of 10 years after full deployment of the FCF, including regularly scheduled and unscheduled maintenance activities.

b. The SAR design to be capable of an extended life to 15 years after full deployment, including regularly scheduled and unscheduled maintenance activities and major component replacement, shall be verified by analysis. Verification shall be considered successful when the analysis shows the SAR is designed to be capable of an extended life to 15 years after full deployment, including regularly scheduled and unscheduled maintenance activities and major component replacement.

4.2.8 Transportation and safety requirements.

Not applicable.

4.2.9 Interfaces.

4.2.9.1 Interfaces within the US Lab.

a. Verification that the SAR connector physically mates with the corresponding module connector shall be verified by demonstration. The demonstration shall use a module connector with the part number specified in Table III and Table IV to verify that the connectors physically mate. The verification shall be considered successful when the demonstration shows the integrated rack connector physically mates with its corresponding module connector.
b. A demonstration shall be conducted using the Payload Rack Checkout Unit (PRCU) or equivalent to show that the umbilicals can successfully reach their intended connector and to observe that the connectors are in a fully mated condition.
c. Verification that the internal interfaces are as specified in FCF-SPC-0004, paragraph 3.1.5.1 shall be verified by inspection of the SAR drawings. The verification shall be considered successful when the inspections of the drawings show that the internal interfaces are as specified in FCF-SPC-0004, paragraph 3.1.5.1.

TABLE III. Electrical/data interfaces between SAR and US Lab

Interface	Module Connector	Part Number
Main Power	J1	NATC07T25LN3SN
Essential/Auxiliary Power	J1	NATC07T25LN3SA
1553 Bus A	J3	NATC07T15N35SN
1553 Bus B	J4	NATC07T15N35SA
HRDL	J7	NATC07T13N4SN
Optical Video	J16	NATC07T15N97SB
Fire Detection System/Power Maintenance	J43	NATC07T13N35SA
LAN-1	J46	NATC07T11N35SB
LAN-2	J47	NATC07T11N35SB

TABLE IV. Fluids interfaces used to connect the SAR to the US Lab

Interface	Part Number
Thermal Control System (TCS) Moderate Supply	683-16348, male, Category 6, Keying B
TCS Moderate Return	683-16348, male, Category 6, Keying C
Gaseous Nitrogen	683-16348, male, Category 8, Keying B
Vacuum Exhaust	683-16348, male, Category 3, Keying B

4.2.9.2 Ground support equipment (GSE) interfaces.

a. Interface compatibility to KSC GSE Rack Insertion Device shall be verified by inspection of the SAR design drawings. Verification shall be considered successful when inspection of the drawings show the interface is compatible with the drawings in SSP 41017. The NASA provided 683–50243–4 ISPR structure is assumed to meet these interfaces, provided that the integrated rack hardware does not exceed the static envelope requirement.
b. SAR interfaces with the RSC shall be verified by a fit check demonstration. The demonstration shall be considered successful when it shows that the SAR can be successfully connected to the RSC. The NASA provided 683–50243–4ISPR structure is assumed to meet these interfaces, provided that the integrated rack hardware does not exceed the static envelope requirement.
c. SAR compatibility with the RHA shall be verified by a fit check demonstration. The demonstration shall be considered successful when it shows that the SAR can be successfully connected to the RHA. The NASA provided 683–50243–4ISPR structure is assumed to meet these interfaces, provided that the SAR does not exceed the static envelope requirement.
d. Ground transportation acceleration limits shall be verified by test and analysis. The test and analysis shall be considered successful when the test provides a measurement of the maximum accelerations encountered during shipment in the 3 orthogonal rack axes and an analysis shows that these accelerations do not exceed 80% of the flight accelerations.

4.2.9.3 MPLM interfaces.

a. Structural attach point compatibility shall be verified by inspection of the SAR drawings and comparison with the table referenced in SSP 41017. The NASA provided 683–50243–4 ISPR structure is assumed to meet these interfaces.
b. An analysis shall be conducted which determines the maximum delta pressure from inside to outside of the SAR and shows that the SAR rack maintains positive margins of safety (delta pressure limited to 3.5 kPa (0.5 psi)). Verification shall be considered successful when the analysis shows that 3.5 kPa (0.5 psi) delta pressure is not exceeded. (Verification may be by inspection of SAR design drawings for NASA provided 683–50243–4 ISPR’s with intact and unblocked pressure relief valves).
c. An analysis shall be conducted using the referenced acceleration data and calculating the interface attach point loads via finite element modeling (FEM). The analysis shall be considered successful when the FEM is approved by the ISS program and it calculates attach point loads that do not exceed the MPLM allowable limits. A coupled loads analysis will be conducted by the ISS program using the FEM provided to ensure that MPLM allowables are not exceeded when coupled loads are taken into account.

4.2.9.4 ISS fluids and vacuum interface requirements.

4.2.9.4.1 Water Thermal Control System (WTCS).

a. WTCS fluid use verification that the coolant contained in the integrated rack interfacing with ITCS coolant satisfies the TCS coolant verification test requirements specified in SSP 30573 shall be by test. The verification shall be considered successful if the test results show the SAR coolant meets the TCS coolant requirements in SSP 30573.
b. WTCS charging verification shall be verified by analysis and certificate of compliance stating the amount of coolant charged into the SAR allows for thermal expansion during transport. The verification shall be considered successful if the amount of coolant charged into the SAR allows for thermal expansion when exposed to the temperature range encountered during transport.
c. Verification that the pressure differential measured across the ITCS supply and return interfaces for the flow rates in the range to be used in flight shall be by test with both halves of each mated QD pair included as part of the payload pressure differential. A curve of flow rate versus pressure drop will be generated for each flow configuration and mode of operation. The verification shall be considered successful if the test results are within the pressure drop requirements specified in Figure 15.

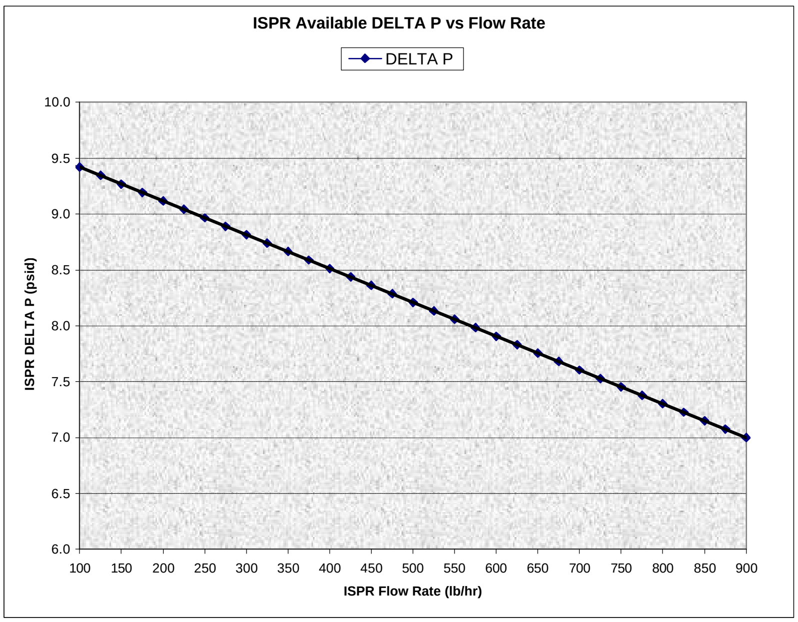


FIGURE 15. US Lab MTL available pressure drop vs. flow rate

d. Verification of compatibility with the design flow rate shall be by analysis or test using the PRCU or equivalent test equipment. The payload developer shall provide the PRCU or equivalent test equipment flow rate measurements for all modes of operations. The verification shall be considered successful if the analysis or test results provide the integrated rack flow rate measurements for all modes of operation at or below the coolant flow rate limits specified in Figure 15.
e. NVR.

f.
1. Verification that the initial configuration of the SAR moderate differential return temperature is above the minimum allowable shall be verified by test and analysis. The test shall utilize a PRCU (or equivalent) to measure the differential temperature for the minimum, maximum, and nominal power modes of the SAR. Analysis shall be used to account for any on-orbit modifications of equipment, using a thermal model adjusted with the results from the SAR return temperature testing, to verify that the changes in equipment satisfy the minimum differential temperature. The verification shall be considered successful when the initial test and subsequent analysis show that the moderate differential return temperature is above the minimum allowable.
2. Verification that the SAR using moderate temperature coolant is designed to operate using 100 lbm/h flow during modes of operation which require less than 1025 W of power shall be verified by analysis. The verification shall be considered successful when the analysis shows that the SAR using moderate temperature coolant is designed to operate using 100 lbm/h flow during operating modes which require less than 1025 W of power.
3. Verification that the initial configuration of the SAR moderate TCS return temperature does not exceed the maximum specified temperature shall be verified by test and analysis. The test shall utilize a PRCU (or equivalent) to measure the outlet temperature for the maximum and nominal power modes of the SAR. Analysis shall be used to account for any on-orbit modifications of equipment, using a thermal model adjusted with the results from the SAR return temperature testing, to verify that the changes in equipment do not exceed the allowable return temperature. The verification shall be considered successful when the initial test and subsequent analysis show that the moderate temperature return limit is not exceeded.

g. The pressure integrity of integrated rack volumes connected to the TCS moderate temperature loop shall be verified by performing a leak-check of the pressure system. The verification shall be considered successful if the test results show the integrated rack passes the leak-check performed at a minimum of 1.0 x MDP per SSP 52005, paragraph 5.1.3.

h. Verification that payload equipment and rack internal water loop piping utilizing the ISS or payload-provided heat rejection system(s) is fail safe in the case of loss of cooling under all modes of operation and will not result in over-temperature, over-pressurization, fire, explosion, release of hazardous or toxic materials, or damage that could propagate to other systems shall be by analysis. If loss of cooling results in a hazard, the controls for shutdown must be verified by test. The verification shall be considered successful if the analysis and/or test results show the integrated rack satisfies the fail safe design criteria.

i. Verification that each ITCS fluid loop including all payload equipment and connections as well as the supply and return interfaces and connections at the Utility Interface Panel does not exceed the leakage requirement shall be by test. The leakage test shall be performed at MDP or above. If helium, or some other medium, is used in testing, the results shall be converted to an equivalent water leakage. The verification shall be considered successful if the test results show the SAR leakage rate to be equal to or less than 14 X 10 -3 scc/h of liquid per each thermal loop.

   NOTE: A conversion factor of 1 scc/h of water = 233 scc/h of helium at a pressure of 121 psia shall be used when converting helium leakage to an equivalent water leakage.

j. Verification that air inclusion into the QD during coupling and uncoupling does not exceed 0.3 cc per couple/uncouple cycle shall be by test or analysis of QD certification data. If air is not used in testing of the QD, the results shall be converted to an equivalent volume of air.

The verification shall be considered successful if the test results show the integrated rack QD air inclusion does not exceed 0.3 cc per couple/uncouple cycle.

k. Verification that the payload control system time constant is of the specified duration shall be by test. The verification shall be considered successful if the test results show the integrated rack time constant for set point changes resulting in flow rate changes greater than 5 lbm/h shall take the specified time to reach 63.2% (i.e., 1-e-1) of the commanded change in flow rate.
l. Verification that the maximum allowable payload coolant quantity is not exceeded shall be by test or analysis of the payload design drawings. The verification shall be considered successful if the test or analysis results show the integrated rack coolant quantity to be within the limits of no more than the maximum allowable coolant quantity of water, referenced at 61°C (141.8°F). The maximum allowable coolant quantity of water in the US Lab MTL is 42.25 gal. (159.9 L).
m. Verification that the maximum allowable payload gas inclusion or volume limit is not exceeded shall be by analysis of the payload design drawings. The verification shall be considered successful if the analysis results show the integrated rack gas inclusion amount to be within the maximum allowable gas inclusion or volume at the maximum design pressure into the US Lab Internal Thermal Control System of 8.88 in3 (0.146 L).
n. The SAR shall verify by demonstration or inspection that the WTCS interfaces with the Fluid System Services. The verification shall be considered successful when the demonstration or inspection shows the WTCS interfaces with the Fluid System Services.

4.2.9.4.2 Vacuum exhaust system/waste gas system (VES/WGS) requirements.

a. SAR vented gas pressure shall be verified by test and analysis. The test shall utilize a PRCU or equivalent to measure the vented gas pressure at the interface plane. The SAR volumes that are connected to ISS VES/WGS shall be pressurized to the expected experiment pressures for the test.
b. The MDP of SAR volumes connected to the VES shall be verified by the test and analysis guidelines identified in SSP 52005, paragraph 5.1.3
c. An analysis shall determine whether or not the SAR (including the experiment chamber) connected to the ISS VES/WGS system provides a two fault tolerant design to prevent venting gases at pressures greater than 276 kPa (40 psia) at the rack to ISS interface. Verification shall be considered successful when the analysis shows the SAR provides a two fault tolerant design to prevent venting gases to the ISS VES/WGS system at pressures greater than 276 kPa (40 psia) at the SAR to ISS interface.
d. SAR temperature shall be verified by test. The test shall utilize a PRCU or equivalent to measure the temperature at the interface plane. The SAR volumes that are connected to VES shall be pressurized to the expected pressures for the test. The experiment shall be subjected to the same heat generating operations that will be experienced on orbit and vented at the same relative time during the experiment operation as would be experienced on orbit.
e. SAR dewpoint shall be verified by test. The test shall utilize a PRCU or equivalent to measure the dewpoint at the interface plane. The SAR volumes that are connected to VES shall be pressurized to the expected pressures for the test. The experiment shall be subjected to the same operations that will be experienced on orbit and vented at the same relative time during the experiment operation as would be experienced on orbit.
f. Verification that exhaust gases vented into the Vacuum Exhaust System/Waste Gas System (VES/WGS) of the US Lab are compatible with the wetted surface materials of the respective

laboratory(ies) in which the SAR will operate shall be by analysis or test. Gases documented in SSP 57000 Appendix D have been analyzed for compatibility with the ISS VES/WGS wetted materials. The SAR provider shall submit a complete list of all proposed vent gas constituents, initial volume, concentration, temperature, and pressure to the ISS program. The list submitted shall also identify which exhaust gases will be vented together and shall include the products of any reactions determined in FCF-SPC-0004, paragraph 3.2.2.9.4.2 g. The ISS module integrator will analyze the list of vent gases not specified in Appendix D and the VES/WGS wetted surface materials to determine whether or not the proposed exhaust gases are compatible with the ISS VES/WGS wetted materials. The ISS program will evaluate and conduct a test if necessary for gases that do not have compatibility documentation to determine whether or not the proposed exhaust gases are compatible with the VES/WGS wetted surface materials. The SAR developer shall review the SAR proposed vent gases and determine whether or not the gases are listed as acceptable in Appendix D or on the report provided by the program in the stage analysis. Verification shall be considered successful when the proposed exhaust gases are shown to be compatible with the ISS VES/WGS wetted surface materials of the respective laboratory(ies) in which the SAR will operate as specified in SSP 57000 Appendix D or in the analysis report from the ISS program. The verification process performed by the ISS program is documented in SSP 57011, Figure 3.4.11–9.
Note: This analysis/test will consider flammability, pitting and general corrosion, and degradation and swelling of seal materials. An analysis will consist of a literature search that will review technical documentation for documented compatibility of exhaust gases with the wetted materials listed in SSP 41002, paragraph 3.3.7.2. Materials and gases will be considered compatible if the documentation shows one of the following: existing use of the material in a system containing the gas in question, test data showing compatibility, or general materials information stating compatibility. For exhaust gases where no technical data showing compatibility is found, a test will be conducted. The test will review material weight loss, wetted material surface changes, soft material swelling, and wetted material trace contaminate inclusion in the test gases after exposure to the materials.

g. Verification that SAR gases vented to the ISS VES/WGS are nonreactive with other vent gas mixture constituents shall be by analysis. An analysis shall determine what gases will be vented to the ISS VES/WGS and, assuming the worst case reactions possible, shall determine all reactions that are possible among the vent gas constituents. An analysis shall calculate the worst case temperature change associated with the possible vent gas reactions in accordance with the equation:

$$20 \geq \frac{\sum_{\text{ALL REACTIONS}} \left[\left[\frac{(\sum x_p H_p - \sum x_{r1} H_r)}{n_{lim}} \right] m_{lim} \right]}{\sum x_p m_p c_{pp} + \sum x_{r2} m_r c_{pr} + \sum x_d m_d c_{pd}}$$

Hp	=	Enthalpy of formation of the products (J/mol)
H	=	Enthalpy of formation of the reactants (J/mol)
Xr1	=	Number of moles of the reactants
Xr2	=	Number of moles of the unreacted reactants

Xp = Number of moles of the products
Xd = Number of moles of the diluent.
Nlim = Molecular Weight of the limiting reactant in the reaction (g/mol)
mlim = Mass of the limiting reactant in the reaction (g)
mp = Mass of each product gas in the vent mixture (g)
mr = Mass of each unreacted reactant gas in the vent mixture (g)
md = Mass of each diluent gas in the vent mixture (g)
cpp = Constant Pressure Heat Capacity of each product gas at the vented condition (J/(g*K))
cpr = Constant Pressure Heat Capacity of each unreacted gas at the vented condition (J/(g*K))
cpd = Constant Pressure Heat Capacity of each diluent gas at the vented condition (J/(g*K))

Note: The exact equation used may vary slightly depending on the units of the data available for the given gases. These variations shall be limited to unit conversions only. The final units of the equation should be a measure of temperature, measured in Celsius or Kelvin. For each possible reaction in the vent gas mixture, all gases associated with the reaction shall be included in the calculation in the numerator. All possible reactions in the vent gases mixture shall be calculated and summed together in the numerator. All gases in the vented mixture should be included in the denominator of the analysis. Unreacted reactants may be summed in the denominator as a diluent, when rich or lean mixtures are expected for a given reaction. When lean or rich mixtures are expected for one reaction, an analysis shall show that the excess reactant gases will not react with another gas in the vent mixture (the original reaction considered should be the worst case reaction, i.e. most energy released). If trace elements (up to the SMAC value) are present and do not participate in a reaction, they may be excluded from this analysis. Verification shall be considered successful when the analysis shows the gases vented to the ISS VES/WGS are nonreactive according to the equation specified above (the equation meets the inequality).

Note: Venting of cabin air; the ISS pressurized gases, nitrogen, carbon dioxide, argon, or helium; or mixtures of these gases is considered acceptable and does not require verification if each is not mixed with other gases.

h. Verification that SAR venting to the ISS VES/WGS provides a means of removing gases that would adhere to the VES/WGS tubing walls at a wall temperature of 4°C (40°F) and a pressure of 10 (-3) torr shall be by analysis. An analysis shall determine whether or not the gas mixture contains gases with a molecular weight greater than 75 amu or gases which have a boiling point greater than 100°C (212°F) at atmospheric pressure. Each proposed vent gas with a molecular weight greater than 75 amu or a boiling point greater than 100°C (212°F) at atmospheric pressure shall be analyzed to determine whether or not the vapor pressure is below a pressure of 10 (-3) torr at 4°C (40°F). This analysis shall be conducted gas-by-gas. If any proposed vent gases are determined to have a vapor pressure below 10 (-3) torr at 4°C (40°F), an analysis shall be conducted to determine whether or not the SAR provides a means to remove these gases from the vent gas mixture prior to venting to the ISS VES/WGS. Or alternatively, each proposed vent gas with a molecular weight greater than 75 amu or a boiling point greater than 100°C (212°F) at atmospheric pressure shall be analyzed to determine whether or not the boiling temperature is above 4°C (40°F) at a pressure of 10 (-3) torr. This analysis shall be conducted gas-by-gas. If any proposed vent gases are determined to have a boiling temperature above 4°C (40°F) at 10 (-3) torr, an analysis shall be conducted to determine whether or not the integrated rack provides a means to remove these gases from the vent gas mixture prior to venting to the ISS VES/WGS. The Clausius–Clapeyron equation or Antoines equation may be used to verify this requirement. Note that it is not required to use these equations, but they may be helpful. Verification shall be considered successful when the analysis shows the gases that will be exposed to the ISS VES/WGS will not adhere to the ISS VES/WGS tubing walls at a wall temperature of 4°C (40°F) at 10 (-3) torr. Gases that will be exposed to the ISS VES/WGS will not adhere to the ISS VES/WGS tubing walls when each vent gas is shown to have a vapor pressure above 10 (-3) torr or 4°C (40°F) or a boiling temperature below 4°C (40°F) at a pressure of 10 (-3) torr and/or, any gases found with a vapor pressure below 10 (-3) torr at 4°C (40°F) or a boiling temperature above 4°C (40°F) at a pressure of 10 (-3) torr are removed from the gas mixture. Note: Cabin air and the ISS pressurized gases, nitrogen, argon, helium and carbon dioxide, may be vented to the ISS VES/WGS without verification of this requirement.

i. Verification that the SAR venting to the ISS VES/WGS remove particulates from vent gases that are larger than 100 µm shall be by analysis. An analysis shall determine whether or not the vent gases will contain particulate contamination larger than 100 microns. Should the analysis show that particulate contamination greater than 100 microns will be introduced into, or generated in, the vent gases, an analysis shall determine whether or not a means or removing the particles above 100 microns before venting to the ISS VES/WGS is included in the SAR design. Verification shall be considered successful when the analysis shows the vent gases will not contain particulate contamination greater than 100 microns. Note: Cabin air and the ISS pressurized gases, nitrogen, argon, helium and carbon dioxide, may be vented to the ISS VES/WGS in the condition delivered to the SAR if it is shown that particulate contamination is not generated within the SAR.
j. NVR.
k. Verification shall be by analysis. The SAR shall submit the list of vented gas constituents, volume, initial temperature, and pressure to the ISS program. The verification shall be considered successful when the Environments Team verifies that the vented gases do not exceed the external contamination limits in the specified section of SSP 30426.
l. NVR.
m. Verification shall be by inspection and analysis. The inspection shall consist of verification that gas containment volume is provided for incompatible gases. The analysis shall verify that the containment volume is sufficient to contain the gas and complies with the pressure vessel requirements identified in SSP 52005, paragraph 5.1.3. The method of transportation of containment volume from on orbit to ground shall be identified.

4.2.9.4.3 VRS/VVS requirements.

a. SAR vented gas pressure shall be verified by test. The test shall utilize a PRCU or equivalent to measure the vented gas pressure at the interface plane. The SAR volumes that are connected to ISS VRS/VVS shall be pressurized to the expected experiment pressures for the test.
b. The MDP of SAR volumes connected to the VRS/VVS shall be verified by the test and analysis guidelines identified in SSP 52005, paragraph 5.1.3.

c. An analysis shall determine whether or not the payload system (including the experiment chamber) connected to the ISS VRS/VVS system provides a two fault tolerant design to prevent venting gases at pressures greater than 276 kPa (40 psia) at the rack to station interface. Verification shall be considered successful when the analysis shows the payload system provides a two fault tolerant design to prevent venting gases to the ISS VRS/VVS system at pressures greater than 276 kPa (40 psia) at the rack to station interface.
d. The throughput to the VRS shall be verified by the test. The test shall utilize a PRCU or equivalent to measure the vented gas throughput at the interface plane.
e. NVR.

4.2.9.4.4 ISS nitrogen usage requirements.

a. Verification of nitrogen flow control shall be by test. The verification shall be considered successful when the test results confirm that the SAR can turn on and off the flow of nitrogen and can control the flow to not exceed the maximum allowable nitrogen flow rate when connected to nitrogen supplied at the maximum and minimum of the specified pressure range.
b. The MDP of SAR volume connected to the nitrogen system shall be verified by the test and analysis guidelines identified in SSP 52005, paragraph 5.1.3. The verification shall be considered successful if the test results show the SAR passes the proof-pressure test.
c. Verification that the SAR nitrogen system is compatible with the nitrogen interface temperature range shall be by test or analysis or both. The verification shall be considered successful when review of nitrogen system components, including component qualification data packs or test results, show that the SAR nitrogen system is compatible with the nitrogen temperature range specified.
d. Verification of SAR nitrogen leakage shall be by test. The verification shall be considered successful when the test results show that the sum of all potential leakage sources from the standoff UIP panel connection to the point to nitrogen flow control in the SAR does not exceed the allowable leakage rate.

4.2.9.5 COF interfaces.

The SAR capability to interface with the COF for structural, fluids, and electrical connections shall be verified by inspection. Verification shall be considered successful when the inspection shows the SAR can interface with the COF for structural, fluids, and electrical connections.

4.2.9.6 SAR to CIR and/or FIR interface.

The SAR use of an adapter, part no. MTP-ADPT connected to a MTFA-12M5 ferule inside a MTP-012M-SM housing to interface with the SAR to transfer data and receive commands from the SAR as described in FCF-SPC-0004, paragraph 3.1.5.1 shall be verified by inspection and test. The inspection verification shall be considered successful when the inspection shows the SAR uses an adapter, part no. MTP-ADPT connected to an MTFA-12M5 ferule inside a MTP-012M-SM housing. The test verification shall be considered successful when the test shows the SAR transfers the data as specified in FCF-SPC-0004, paragraph 3.1.5.1.

4.2.9.7 SAMS data interface.

<TBD 04-02>

4.3 Reliability.

Not applicable.

4.4 Maintainability.

The SAR not exceeding <TBD 04-03> on orbit MMCH/Y for scheduled and unscheduled maintenance activities including inspections, preventative and corrective maintenance, restorations, and replacement of assemblies and components shall be verified by analysis. Verification shall be considered successful when the analysis shows the SAR does not exceed <TBD 04-03> on orbit MMCH/Y for scheduled and unscheduled maintenance activities including inspections, preventative and corrective maintenance, restorations, and replacement of assemblies and components.

4.4.1 SAR maintenance access.

The SAR capability to allow replacement of ORU’s and failed components and performance of other internal maintenance activities without rotating the SAR from its installed position within the US Lab shall be verified by demonstration. Verification shall be considered successful when the demonstration shows the SAR can allow replacement of ORU’s and failed components and performance of other internal maintenance activities without rotating the SAR from its installed position within the US Lab.

4.4.2 Maintenance item temporary restraint and stowage.

SAR maintenance items designed to allow for temporary restraint and/or stowage during maintenance activities shall be verified by inspection. Verification shall be considered successful when the inspection shows the SAR maintenance items are designed to allow for temporary restraint and/or stowage during maintenance activities.

4.4.3 Tool usage for maintenance.

The SAR capability to be maintained using the ISS tools as defined in SSP 57020 shall be verified by analysis. Verification shall be considered successful when the analysis shows the SAR can be maintained using the ISS tools as defined in SSP 57020.

4.4.4 Lockwiring and staking.

Verification that all SAR maintenance items are not lockwired or staked during installation shall be by inspection. Verification shall be considered successful when the inspection shows all SAR maintenance items are not lockwired or staked.

4.4.5 Redundant paths.

The SAR capability, with applicable PI hardware, to provide alternate or redundant functional paths of all electrical and electronic harnesses that cannot be replaced on orbit shall be verified by analysis. Verification shall be considered successful when the analysis shows the SAR, with applicable PI hardware, can provide alternate or redundant functional paths of all electrical and electronic harnesses that cannot be replaced on orbit.

4.4.6 SAR reconfiguration for out-of tolerance conditions.

The SAR capability, with applicable PI hardware, to allow visual and tactile access to all avionics hardware for at least one hour during troubleshooting operations without detrimental effects to the crew, the ISS, or SAR hardware shall be verified by test. Verification shall be considered successful when the test shows the SAR, with applicable PI hardware, can allow visual and tactile access to all avionics hardware for at least one hour during troubleshooting operations without detrimental effects to the crew, the ISS, or SAR hardware.

4.5 Availability.

The SAR, with applicable PI hardware and spares, operational availability of 92.92% for a base operational life of 10 years with an extendable life to 15 years, in accordance with the formula:

A_0 = MTBM/MTBM+MDT

Where MTBM = Mean Time Between Maintenance and MDT = Mean Delay Time

shall be verified by analysis. Verification shall be considered successful when the analysis shows the SAR, with applicable PI hardware and spares, has an inherent availability of 92.92%.

4.6 Environmental conditions.

4.6.1 Shipping and storage environment.

4.6.1.1 Nonoperating atmospheric environment.

a. The SAR nonoperating temperature range from 2 to 50°C (35.6 to 122°F) shall be verified by test. Verification shall be considered successful when the test shows the SAR can operate during thermal cycle testing after exposure to a nonoperating temperature range from 2°C (35.6°F) to 50°C (122°F).
b. The SAR nonoperating pressure range from 0 to 104.8 kPa shall be verified by analysis. Verification shall be considered successful when the test shows the SAR can operate after exposure to a nonoperating pressure range from 0 to 104.8 kPa.
c. The SAR nonoperating relative humidity range from 10 to 90% shall be verified by analysis. Verification shall be considered successful when the analysis shows the SAR can operate within its designed operating humidity range after exposure to a nonoperating relative humidity range from 10 to 90%.

4.6.1.2 Operating atmospheric environment.

a. The CIR operating temperature range from 17 to 30°C (35.6 to 122°F) shall be verified by test. Verification shall be considered successful when the test shows the CIR can operate during thermal cycle testing after exposure to a nonoperating temperature range from 17 to 30°C (35.6 to 122°F).
b. The CIR operating pressure range from 95.8 to 104.8 kPa shall be verified by analysis. Verification shall be considered successful when the analysis shows the CIR can operate after exposure to a nonoperating pressure range from 95.8 to 104.8 kPa.
c. The CIR operating relative humidity range from 25 to 75% shall be verified by analysis. Verification shall be considered successful when the analysis shows the CIR can operate within its designed operating humidity range after exposure to a nonoperating relative humidity range from 25 to 75%.

4.6.2 MPLM/on-orbit environmental conditions.

The SAR capability, with the applicable PI hardware, to operate within the MPLM/on-orbit environmental conditions as specified in Table V shall be verified by analysis. The verification shall be considered successful when analysis shows that the SAR, with the applicable PI hardware, can operate in the MPLM/on-orbit environmental conditions as specified in Table V.

4.6.3 On-orbit condensation.

The SAR design to not cause condensation when exposed to the ISS atmosphere ranging in dewpoint from 4.4 to 15.6°C (40 to 60°F) and in relative humidity from 25 to 75% shall be verified by analysis. The verification shall be considered successful when the analysis shows that no internal or external surfaces in contact with the ISS cabin air will allow condensation when humidity and dewpoint are within the ISS atmosphere envelope defined by Figure16. Surfaces shall be considered to be in contact with the ISS cabin air unless a volume is hermetically sealed or environmentally conditioned to control humidity.

4.6.4 Special environmental conditions.

4.6.4.1 Load requirements.

a. An analysis shall be conducted which uses the referenced acceleration data and determines SAR structure loads via FEM. The analysis shall be considered successful when the FEM is approved by the ISS program and the model determines SAR structure loads that maintain positive margins of safety, based upon the rack structure allowables identified in SSP 57007.
b. An analysis shall be conducted to verify that the SAR will maintain positive margins of safety during a transient or continuous on-orbit load of 0.2 g acting in any direction.
c. The SAR design drawings shall be inspected to ensure that hardware is provided for restraint of RUP umbilicals during launch and landing.

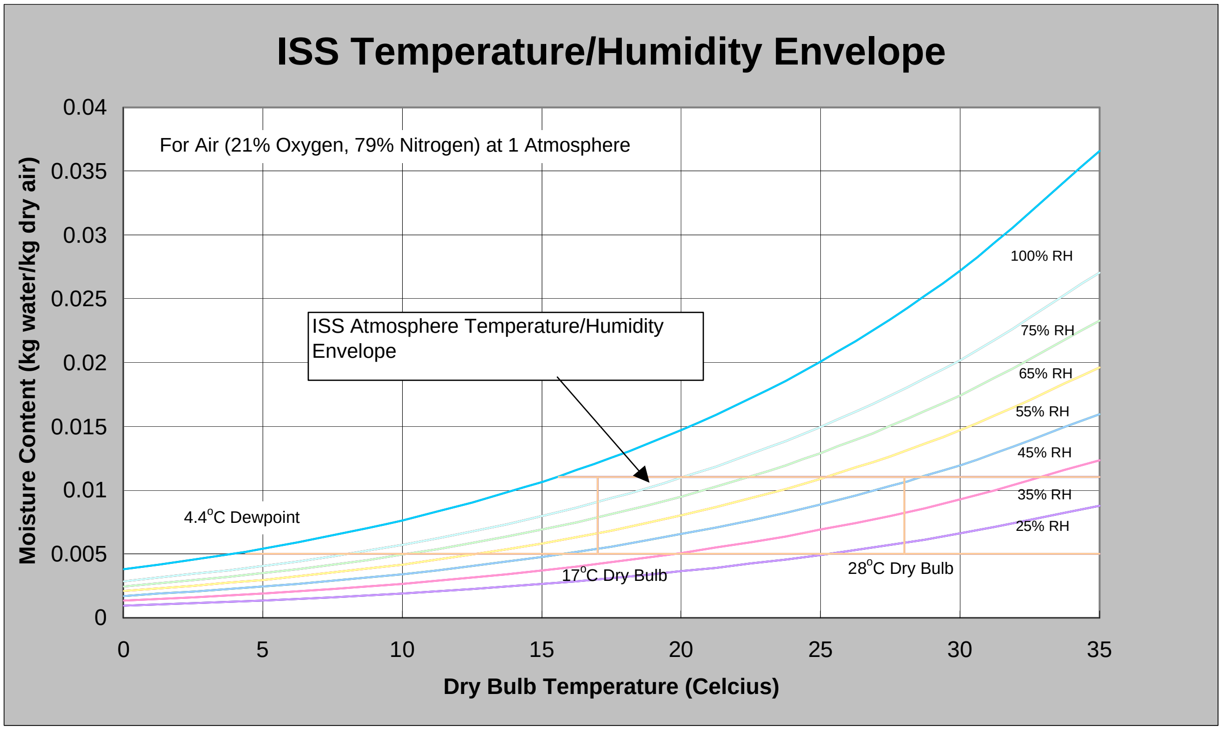


FIGURE 16. ISS temperature/humidity envelope

TABLE V. MPLM/on-orbit environmental conditions

Environmental Condition	Value	
Atmospheric Conditions on ISS		
Pressure Extremes	0 to 104.8 kPa (0 to 15.2 psia)	
Normal operating pressure	See Figure 17	
Oxygen partial pressure	See Figure 17	
Nitrogen partial pressure	See figure 17	
Dewpoint	4.4 to 15.6°C (40 to 60°F) ref. Figure 16	
Percent relative humidity	25 to 75% ref. Figure 16	
Carbon dioxide partial pressure during normal operations with 6 crewmembers plus animals	24-hr average exposure 5.3 mm Hg Peak exposure 7.6 mm Hg	
Carbon dioxide partial pressure during crew changeout with 11 crewmembers plus animals	24-hr average exposure 7.6 mm Hg Peak exposure 10 mm Hg	
Cabin air temperature in USL, JEM, APM, and CAM	17 to 28°C (63 to 82°F)	
Cabin air temperature in Node 1	17 to 31°C (63 to 87°F)	
Air velocity (Nominal)	0.051 to 0.203 m/s (10 to 40 ft/min)	
Airborne microbes	Less than 1000 CFU/m3	
Atmosphere particulate level	Average less than 100,000 particles/ft3 for particles less than 0.5 microns in size	
MPLM Air Temperatures	**Passive Flights**	**Active Flights**
Pre-Launch	15 to 24°C (59 to 75.2°F)	14 to 30°C (57.2 to 86°F)
Launch/Ascent	14 to 24°C (57.2 to 75.2°F)	20 to 30°C (68 to 86°F)
On-orbit (Cargo Bay + Deployment)	24 to 44°C (75.2 to 111.2°F)	16 to 46°C (60.8 to 114.8°F)
On-orbit (On-Station)	23 to 45°C (73.4 to 113°F)	16 to 43°C (60.8 to 109.4°F)
On-orbit (Retrieval + Cargo Bay)	17 to 44°C (62.6 to 111.2°F)	11 to 45°C (51.8 to 113°F)
Descent/Landing	13 to 43°C (55.4 to 109.4°F)	10 to 42°C (50 to 107.6°F)
Post-Landing	13 to 43°C (55.4 to 109.4°F)	10 to 42°C (50 to 107.6°F)
Ferry Flight	15.5 to 30°C (59.9 to 86°F)	15.5 to 30°C (59.9 to 86°F)
MPLM Maximum Dewpoint Temperatures		
Pre-Launch	13.8°C (56.8°F)	12.5°C (54.5°F)
Launch/Ascent	13.8°C (56.8°F)	12.5°C (54.5°F)
On-orbit (Cargo Bay + Deployment)	13.8°C (56.8°F)	12.5°C (54.5°F)
On-orbit (On-Station)	15.5°C (60°F)	15.5°C (60°F)
On-orbit (Retrieval + Cargo Bay)	10°C (50°F)	10°C (50°F)
Descent/Landing	10°C (50°F)	10°C (50°F)
Post-Landing	10°C (50°F)	10°C (50°F)
Ferry Flight	15.5°C (60°F)	15.5°C (60°F)
Thermal Conditions		
USL module wall temperature	13°C to 43°C (55°F to 109°F)	
JEM module wall temperature	13°C to 45°C (55°F to 113°F)	
APM module wall temperature	13°C to 43°C (55°F to 109°F) (TBR #4)	
CAM module wall temperature	13°C to 43°C (55°F to 109°F) (TBR #5)	
Other integrated payload racks	Front surface less than 37°C (98.6°F)	
*** Microgravity**		
Quasi-Steady State Environment	See Figure 18, Figure 19, and Table VI	
Vibro-acoustic Environment	See Figure 20	
General Illumination	108 Lux (10 fc) measured 30 inches from the floor in the center of the aisle	
* Note: Data reflects best available information as of May, 1997. Does not include effects of CAM.		

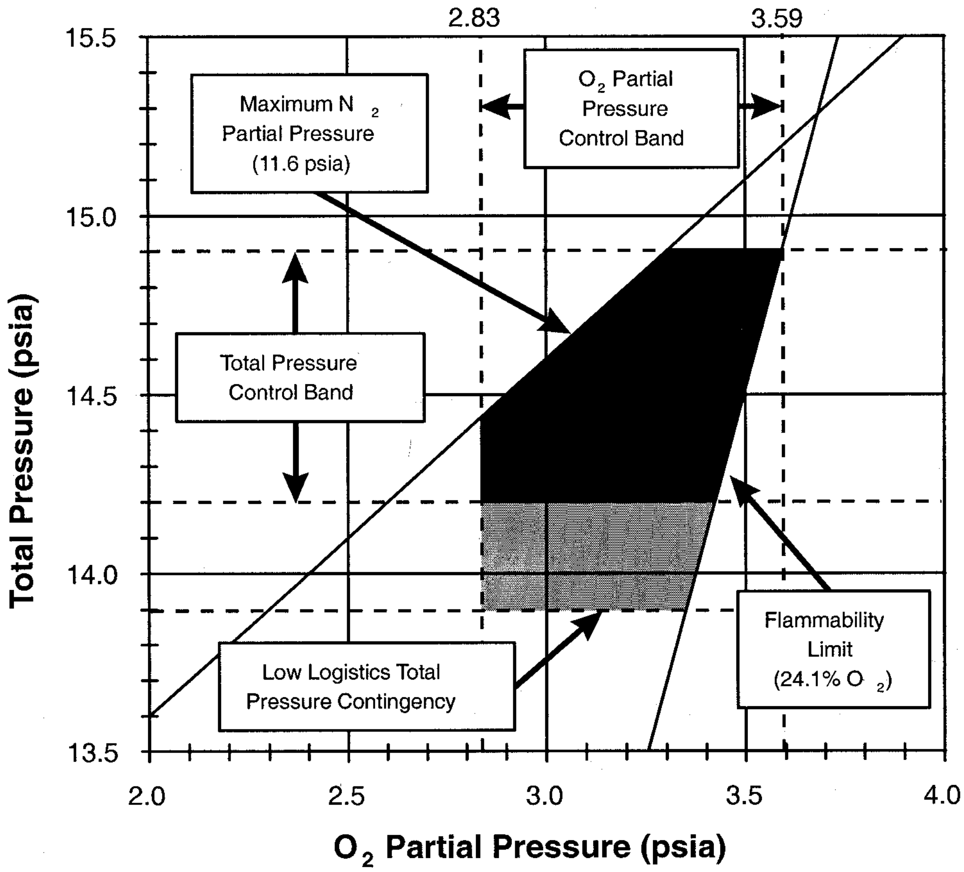


FIGURE 17. Operating limits of the ISS atmospheric total pressure, nitrogen, and oxygen partial pressures

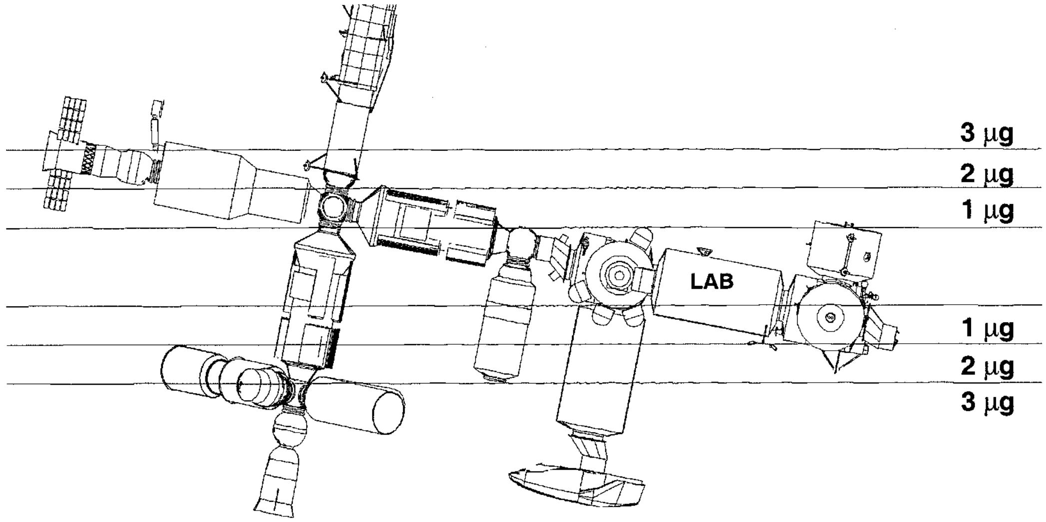


FIGURE 18. Assembly complete quasi-steady state microgravity contours (side)

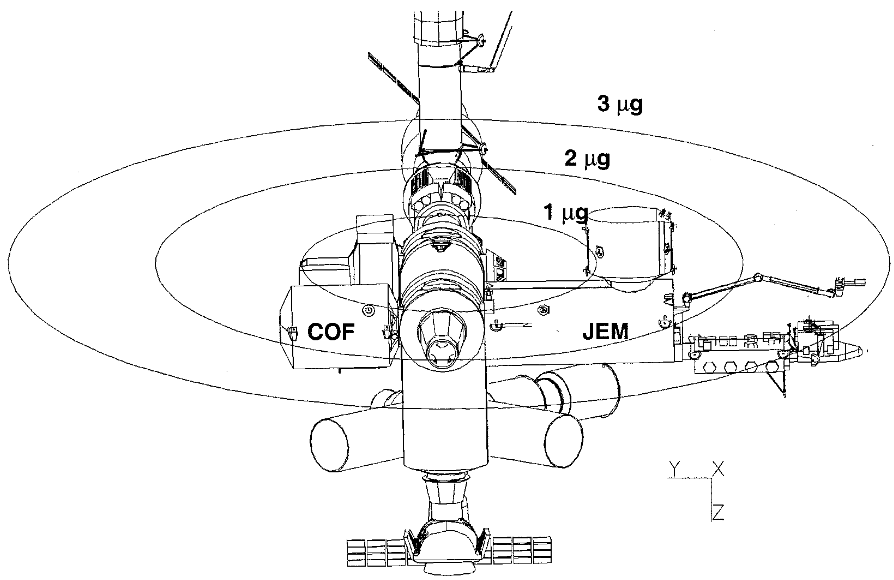
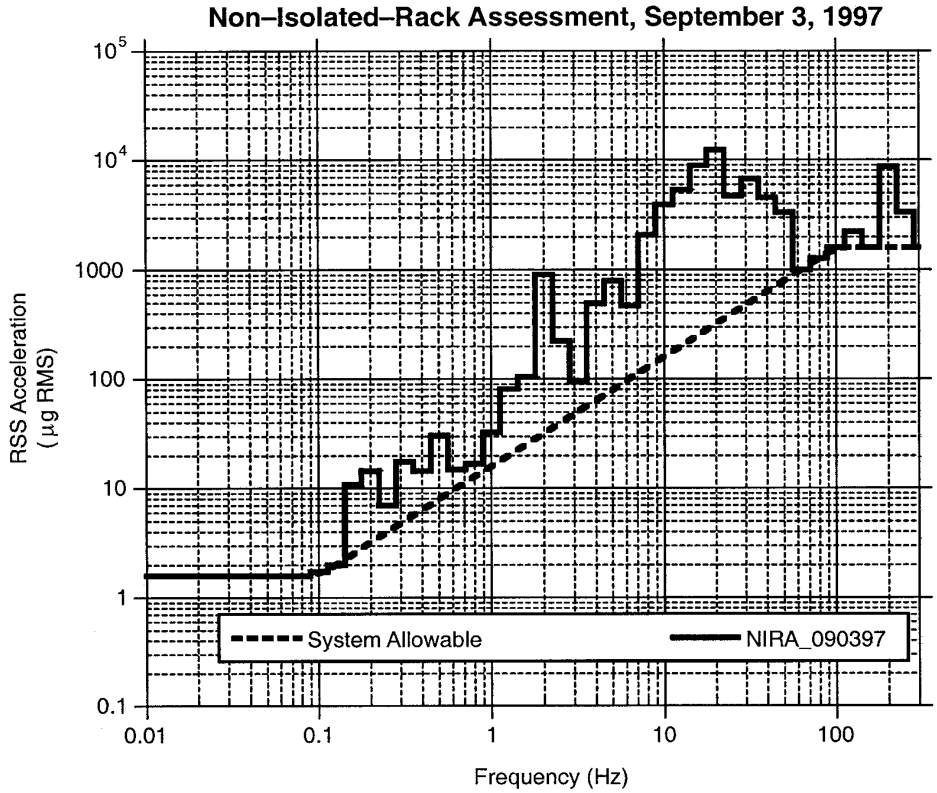


FIGURE 19. Assembly complete quasi-steady state microgravity contours (front)

TABLE VI. Assembly complete quasi-steady state microgravity environment

Location	Magnitude	Stability	Unit Vector Components			Angle	Location	Magnitude	Stability	Unit Vector Components			Angle
(ISPRs)	(μg)	(μg)	X	Y	Z	(deg)	(Others)	(μg)	(μg)	X	Y	Z	(deg)
USL–C1	**0.525**	0.126	0.641	–0.109	0.760	17.370	USL–CG	0.793	0.137	0.466	–0.052	0.883	10.360
USL–C2	**0.468**	0.116	0.721	–0.133	0.680	20.710	APM–CG	1.624	0.157	0.288	–0.533	0.795	5.547
USL–C3	**0.419**	0.100	0.819	–0.165	0.549	24.820	APM–CLG1	1.010	0.151	0.350	–0.649	0.676	8.635
USL–C4	**0.380**	0.078	0.922	–0.204	0.330	28.370	APM–CLG2	1.120	0.154	0.313	–0.726	0.612	7.944
USL–C5	**0.356**	0.064	0.972	–0.237	–0.002	25.280	RS–FGB	1.119	0.139	–0.003	–0.060	–0.998	7.802
USL–S1	1.062	0.145	0.385	–0.227	0.895	7.927	RS–SM	2.179	0.129	–0.099	–0.038	–0.994	3.655
USL–S2	**0.989**	0.143	0.400	–0.248	0.883	8.421	JEM–CG	1.811	0.157	0.244	0.745	0.621	5.143
USL–S3	**0.917**	0.141	0.417	–0.272	0.867	8.973	JEF1–F1	2.954	0.165	0.223	0.627	0.746	3.325
USL–S4	**0.846**	0.138	0.437	–0.300	0.848	9.859	JEF2–A1	2.613	0.160	0.218	0.706	0.674	3.646
USL–P1	1.019	0.145	0.396	0.166	0.903	8.310	JEF3–F2	3.039	0.167	0.216	0.658	0.722	3.265
USL–P2	**0.945**	0.143	0.413	0.180	0.893	8.866	JEF4–A2	2.710	0.162	0.209	0.734	0.646	3.558
USL–P4	**0.799**	0.138	0.458	0.215	0.862	10.230	JEF5–F3	3.129	0.169	0.209	0.685	0.698	3.208
JPM1–A1	1.250	0.150	0.348	0.333	0.877	7.015	JEF6–A3	2.811	0.164	0.201	0.760	0.619	3.477
JPM2–F1	1.480	0.154	0.325	0.282	0.903	6.095	JEF7–F4	3.223	0.171	0.203	0.710	0.674	3.155
JPM3–A2	1.296	0.151	0.334	0.433	0.838	6.819	JEF8–A4	2.915	0.167	0.194	0.782	0.593	3.401
JPM4–F2	1.519	0.154	0.316	0.370	0.874	5.979	JEF9–O1	3.303	0.174	0.188	0.771	0.608	3.135
JPM5–A3	1.355	0.151	0.318	0.520	0.793	6.570	JEF10–O2	3.091	0.174	0.174	0.838	0.517	3.334
JPM6–F3	1.569	0.155	0.305	0.450	0.839	5.824	JEF11–U1	2.456	0.169	0.184	0.861	0.474	4.064
JPM7–A4	1.425	0.152	0.301	0.594	0.746	6.288	JEF12–U2	2.553	0.171	0.170	0.890	0.423	3.955
JPM8–A5	1.505	0.153	0.284	0.657	0.699	5.992	S3LO	3.299	0.223	0.038	–0.994	–0.104	3.918
JPM9–F5	1.700	0.156	0.280	0.584	0.762	5.441	S3LI	2.945	0.212	0.042	–0.991	–0.124	4.180
JPM10–F6	1.778	0.157	0.266	0.638	0.723	5.234	S3UO	3.958	0.209	–0.056	–0.846	–0.530	3.142
APM–FWD1	1.605	0.155	0.305	–0.386	0.871	5.573	S3UI	3.644	0.196	–0.062	–0.810	–0.584	3.222
APM–FWD2	1.681	0.157	0.291	–0.465	0.836	5.370	P3LO	3.260	0.191	0.022	0.973	–0.231	3.355
APM–FWD3	1.768	0.159	0.277	–0.532	0.800	5.167	P3UO	4.043	0.176	–0.068	0.780	–0.622	2.494
APM–FWD4	1.863	0.161	0.263	–0.590	0.763	4.968							
APM–AFT1	1.397	0.152	0.318	–0.451	0.834	6.275							
APM–AFT2	1.482	0.154	0.300	–0.534	0.791	5.989	10 ISPRs Have Quasi–Steady Magnitude </= 1.0 g						
APM–AFT3	1.578	0.157	0.282	–0.603	0.747	5.709							
APM–AFT4	1.682	0.160	0.264	–0.659	0.704	5.450							



Note: The Non-Isolated Rack Assessment (NIRA) is a prediction of the "vehicle induced", Assembly Complete, acceleration environment at non-isolated ISPRs during microgravity mode. The acceleration environment depicted represents a 100 second, root-mean-square average per one-third octave band from 0.01 to 300 Hz at the rack to module structural interfaces. It is intended to represent the enveloped acceleration response over all the non-isolated ISPR locations in the U.S. Lab, JEM, and APM. The NIRA is based on the DAC–4 ISS assessment of vehicle microgravity compliance which computed the acceleration response to all significant U.S. and Russian segment disturbance sources. To account for the ESA and NASDA disturbance sources, the NIRA at this time assumes that the acceleration responses produced by the ESA and NASDA disturbances are equivalent to the responses produced by the U.S. Lab, Hab, and Airlock disturbances combined less exercise equipment. A similar assumption is also used to account for the CAM in this NIRA. Thus, with these assumptions, the NIRA accounts for all "vehicle induced" accelerations during microgravity mode. The NIRA does not account for "payload induced" accelerations nor "crew induced" accelerations, other than those produced by the crew when using exercise devices. The NIRA is expected to be updated as improved predictions become available.

FIGURE 20. Assembly complete vibratory environment

d. An analysis shall be performed to show that SAR equipment exposed to the crew translation path maintains a positive margin of safety when exposed to the crew-induced loads as defined in Table VII. The verification shall be considered successful when the analysis shows positive margins exist for yield and ultimate loads for utility lines and for ultimate loads for all other exposed equipment.
e. An analysis shall be performed to show that the components mounted to ISPR posts maintain positive margins of safety for the MPLM launch random vibration environment per Tables VIII or IX. This analysis shall follow the guidelines provided in SSP 52005, paragraphs 4.1.2 and 4.1.5. The verification shall be considered successful when the analysis shows that components mounted to ISPR posts maintain positive margins of safety.
f. An analysis shall be performed to show that the components mounted to the ISPR's maintain positive margins of safety after exposure to the design load factors for launch and landing environments per Table X. This analysis shall follow the guidelines provided in SSP 52005, paragraphs 4.1.2 and 4.1.3. The verification shall be considered successful when the ISS-performed coupled loads analysis shows that the components mounted to the ISPR's maintain positive margins of safety.

TABLE VII. Crew-induced loads

CREW SYSTEM OR STRUCTURE	TYPE OF LOAD	LOAD	DIRECTION OF LOAD
Levers, Handles, Operating Wheels, Controls	Push or Pull concentrated on most extreme edge	222.6 N (50 lbf), limit	Any direction
Small Knobs	Twist (torsion)	14.9 N–m (11 ft-lbf), limit	Either direction
Exposed Utility Lines (Gas, Fluid, and Vacuum)	Push or Pull	222.6 N (50 lbf)	Any direction
Rack front panels and any other normally exposed equipment	Load distributed over a 4 inch by 4 inch area	556.4 N (125 lbf), limit	Any direction
Legend: ft = feet, m = meter, N = Newton, lbf = pounds force			

TABLE VIII. Random vibration criteria for ISPR post-mounted equipment weighing 100 pounds or less in the MPLM

FREQUENCY	LEVEL
20 Hz	0.005 g^2/Hz
20–70 Hz	+ 5.0 dB/oct
70–200 Hz	0.04 g^2/Hz
200–2000 Hz	–3.9 dB/oct
2000 Hz	0.002 g^2/Hz
Composite	4.4 grms
Note: Criteria is the same for all directions (X,Y,Z)	

TABLE IX. Random vibration criteria for ISPR post-mounted equipment weighing more than 100 pounds in the MPLM

FREQUENCY	LEVEL
20 Hz	0.002 g2/Hz
20–70 Hz	+ 4.8 dB/oct
70–200 Hz	0.015 g2/Hz
200–2000 Hz	–3.7 dB/oct
2000 Hz	0.0006 g2/Hz
Composite	2.4 grms
Note: Criteria is the same for all directions (X,Y,Z)	

TABLE X. Payload ISPR mounted equipment load factors (equipment frequency 35 Hz)

Liftoff	X	Y	Z
(g)	± 7.7	± 11.6	± 9.9
Landing	**X**	**Y**	**Z**
(g)	± 5.4	± 7.7	± 8.8
Note: Load factors apply concurrently in all possible combinations for each event and are shown in the rack coordinate system defined in SSP 41017, Part 2, paragraph 3.1.3.			

4.6.4.2 Rack requirements.

a. An analysis shall be conducted which determines the maximum delta pressure from within to outside the SAR and shows that the SAR maintains positive margins of safety (delta pressure limited to 3.5 kPa (0.5 psi)). Verification shall be considered successful when the analysis shows that 3.5 kPa (0.5 psi) delta pressure is not exceeded. (Verification may be by inspection of SAR design drawings for NASA provided 683–50243–4 ISPR's with intact and unblocked pressure relief valves.)
b. An analysis shall be conducted using the guidelines provided in SSP 52005 Appendix C.1.2.2. A modal survey test shall be performed to verify the analysis. The verification shall be considered successful when the analysis shows that the SAR and kneebrace meet the frequency requirement specified, and the modal survey test shows the SAR and kneebrace meet the frequency requirement specified.
c. Information – no verification required.
d. Verification shall be by inspection or analysis of the umbilical routing drawing to ensure that the keep-out zone is provided. The verification shall be considered successful when the inspection shows that the envelope (or keep-out zone) is provided, or analysis shows that the umbilicals can be moved out of the envelope without exceeding any umbilical bend radii requirements.

e. An analysis shall be conducted using SAR and module data to evaluate the maximum rotation angle of the SAR rack. The verification shall be considered successful when the rotation angle is calculated to be at least 80 degrees.
f. An analysis shall be conducted which determines the maximum delta pressure from within to outside the SAR during PFE discharge, shows that the SAR maintains positive margins of safety (delta pressure limited to 3.5 kPa (0.5 psi)), and shows that SAR equipment maintains positive margins of safety. Verification shall be considered successful when the analysis shows that the structures maintain positive margins.
g. Verification of SAR positional and crew restraints at rotation angles shall be by analysis. The analysis shall show the use of restraints to maintain the SAR in the position required for payload operations and maintenance. Verification shall be considered successful when the analysis shows that the ISS provided hardware can secure the SAR in the required rotation positions.
h. Verification that the SAR does not have a pressure relief device on the front of the rack shall be by inspection. Verification shall be considered successful when the inspection shows the SAR does not have a pressure relief device on the front of the rack.
i. Verification that the SAR is designed in accordance with the requirements specified in SSP 52005 shall be by inspection. Verification shall be considered successful when the inspection shows that the requirements as specified in SSP 52005 are met. Data certification that provides a summary of margins for all safety critical structures identified in accordance with SSP 52005 using design loads shall be sent to the ISS Program Office no later that L-22 months. Data certification that provides a summary of the margins of safety for all safety critical structures identified in accordance with SSP 52005 using loads from Design Loads Analysis results shall be sent to the ISS Program Office no later then L-12 months. Data certification that provides a summary of the margins of safety for all safety critical structures identified in accordance with SSP 52005 using loads validated by the Verification Lads Analysis results shall be sent to the ISS Program Office no later than L-5 months.
j. Forces produced by a payload below 0.01 Hz shall be verified by analysis against FCF-SPC-0004, paragraph 3.2.6.4.2 j. This analysis shall be considered successful when it is shown that no impulse is exerted by the payload to the ISS, either directly or through the ISS vent/exhaust systems, greater than 10 lb-s (44 N-s) over any 10 to 500 second interval.
k. Verification of SAR mechanical vibration against FCF-SPC-0004, paragraph 3.2.6.4.2 k FCF-SPC-0004 shall be accomplished by FEM, Statistical Energy Analysis (SEA), test, or simplified analysis as discussed in the following paragraphs. SEA may be performed where sufficient modal density is present as defined by the SEA parameter limitations explanation included with the SEA model. FEM analysis may be performed to either the ISS side of the rack attachment brackets interface using a force limit requirement of Table XI or to an assumed adjacent ARIS rack interface using the interface acceleration limit requirement of Table XII. In applying these methods, the following are to be observed:
    1. SAR FEM models must use a damping factor of 0.5% unless alternative damping values are shown appropriate by test. Damping coefficient test data must be obtained using force levels no greater than the maximum disturbance force allowable to meet microgravity requirements and at the approximate location for the SAR disturbance. High strain producing test methods are to be avoided since such test may increase damping, leading to misleading results.
    2. The one-third octave force limits include allowance for SAR frequency deviation as large as 10% from predicted or measured values. If the SAR has a disturbance frequency

variation and uncertainty which exceeds 10% shall use worst-case assumptions for frequency disturbances close to one-third octave boundaries.

3. If multiple disturbance sources that are not phase synchonized are modeled, then the effect of each source operating independently is to be added in RSS fashion. If the disturbance sources are phase synchonized then the sum of the vibration contributions for each disturber in phase must be added at each resultant point in each axis prior to obtaining the RSS.
4. To ensure capture of modal peak responses in finite element frequency domain verification procedures, the transfer function and/or response analysis should explicitly include the modal frequencies of the finite element model. These should be supplemented with additional frequencies to adequately capture off-peak responses. It is required that the supplemental frequency density be sufficient to include at least one additional frequency within the half-power bandwidth of the modes. A constant logarithmic frequency spacing in which the delta frequency factor (deltafreq=deltafreqfac*lastfreq) is less than the half-power bandwidth (halfpowbw=2*c/ccrit) provides such a condition.
5. For the frequency range above 50 Hz, either SEA or FEM may be used. SEA models shall use a loss factor coefficient of 0.5% unless alternative values are justified by payload test. FEM models are to be used to the highest frequency verified by test. FEM models may also be used beyond the range verifiable by test to envelope possible rack response as an alternative to SEA. The RSS of each one-third octave band plus one fourth of the RSS of each adjacent band as obtained by rack models applied to measured rack disturbances may be used to envelope FEM force response in the extended frequency range. Test data analysis may be used to adjust the damping coefficient used in either FEM or SEA models or to adjust the coupling coefficients and loss factor used for SEA models.
6. Disturbance forces must be applied to transfer functions from Force Spectral Density (FSD) form for each one-third octave. The RSS value for each incremental division of FSD (f) contribution of multiple sources, wide-band and narrow-band, are to be added to yield a total FSD (f) for each frequency subdivision before Frms is calculated. Values are given either as wide-band (an rms value and a frequency range) or as narrow-band (an rms value and a discrete frequency). Wide-band rms one-third octave data are to be converted to FSD (f) per the following equation:

$$\mathrm{FSD}(f) = \frac{\mathrm{Frms}^2}{\Delta\,\mathrm{fto}}$$

   Where Frms is the database rms force value and Δfto is the bandwidth of the one-third octave band. Narrow-band data base values are to be converted to FSD (f) by the same expression adding the data base rms value only in the single frequency subdivision spanning the data base frequency. The FSD (f) contribution for multiple sources, wideband and narrowband, are to be added to yield a total FSD (f) for each frequency subdivision before Frms is calculated.

   The method used for combining results to obtain peak rms for each one-third octave is dependent upon the verification method used. Method A will be used for payloads employing the interface force method and Method B will be used for payloads employing integrated payload and ISS models.

TABLE XI. Allowable integrated rack narrow-band envelope and wideband interface force values for ISPR's, 0.5% damping factor

Freq (Hz)	NB lb f	WB Lb f	Freq (Hz)	NB lb f	WB Lb f	Freq (Hz)	NB lb f	WB Lb f
0.008913	0.06261	0.089635	0.3548	0.061482	0.224779	11.22	0.817148	3.451307
0.01122	0.06261	0.089635	0.3548	0.030924	0.378806	14.13	0.817148	3.451307
0.01122	0.06261	0.073218	0.4467	0.030924	0.378806	14.13	0.579786	3.358266
0.01413	0.06261	0.073218	0.4467	0.038934	0.138909	17.78	0.579786	3.358266
0.01413	0.068172	0.084667	0.5623	0.038934	0.138909	17.78	0.516921	2.048448
0.01778	0.068172	0.084667	0.5623	0.04901	0.274588	22.39	0.516921	2.048448
0.01778	0.079202	0.097495	0.7079	0.04901	0.274588	22.39	0.57451	2.091627
0.02239	0.079202	0.097495	0.7079	0.06922	0.222568	28.18	0.57451	2.091627
0.02239	0.091377	0.112968	0.8913	0.06922	0.222568	28.18	0.168996	1.443748
0.02818	0.091377	0.112968	0.8913	0.087153	0.404688	35.48	0.168996	1.443748
0.02818	0.105641	0.133067	1.122	0.087153	0.404688	35.48	0.212776	0.50643
0.03548	0.105641	0.133067	1.122	0.154561	1.337042	44.67	0.212776	0.50643
0.03548	0.123739	0.161094	1.413	0.154561	1.337042	44.67	0.267886	1.498072
0.04467	0.123739	0.161094	1.413	0.976353	4.322593	56.23	0.267886	1.498072
0.04467	0.134457	0.205508	1.778	0.976353	4.322593	56.231	0.10793	0.431721
0.05623	0.134457	0.205508	1.778	1.953413	8.01995	70.79	0.10793	0.431721
0.05623	0.042699	0.22137	2.239	1.953413	8.01995	70.791	0.122491	0.489965
0.07079	0.042699	0.22137	2.239	0.915835	7.567684	89.13	0.122491	0.489965
0.07079	0.042699	0.158917	2.818	0.915835	7.567684	89.131	0.143827	0.575309
0.08913	0.042699	0.158917	2.818	0.818034	3.504552	100	0.143827	0.575309
0.08913	0.042699	0.2093	3.548	0.818034	3.504552	112.2	0.143827	0.575309
0.1122	0.042699	0.2093	3.548	1.029953	3.531682	112.2	0.135367	0.541469
0.1122	0.030213	0.373089	4.467	1.029953	3.531682	141.3	0.135367	0.541469
0.1413	0.030213	0.373089	4.467	0.460611	2.979207	141.3	0.115819	0.463274
0.1413	0.017289	0.146008	5.623	0.460611	2.979207	177.8	0.115819	0.463274
0.1778	0.017289	0.146008	5.623	0.579824	2.330438	177.8	0.116941	0.467763
0.1778	0.021755	0.083429	7.079	0.579824	2.330438	223.9	0.116941	0.467763
0.2239	0.021755	0.083429	7.079	0.315606	1.16448	223.9	0.104363	0.417452
0.2239	0.027396	0.24715	8.913	0.315606	1.16448	281.8	0.104363	0.417452
0.2818	0.027396	0.24715	8.913	0.39737	4.848007	281.8	0.097688	0.390751
0.2818	0.061482	0.224779	11.22	0.39737	4.848007	354.8	0.097688	0.390751

TABLE XII. Non-ARIS integrated rack to ARIS acceleration limit alternative to force limits

Freq	Accel Limit (ug)	Freq	Accel Limit (ug)	Freq	Accel Limit (ug)
0.0089	0.159	0.226	5.18	5.74	2746
0.0112	0.159	0.285	5.18	7.23	2746
0.0112	0.185	0.285	8.19	7.23	4026
0.0141	0.185	0.359	8.19	9.11	4026
0.0141	0.213	0.359	12.97	9.11	5758
0.0178	0.213	0.452	12.97	11.48	5758
0.0178	0.244	0.452	20.53	11.48	8021
0.0224	0.244	0.570	20.53	14.47	8021
0.0224	0.281	0.570	32.49	14.47	10898
0.0283	0.281	0.718	32.49	18.23	10898
0.0283	0.325	0.718	51.42	18.23	14495
0.0356	0.325	0.904	51.42	22.96	14495
0.0356	0.383	0.904	81.33	22.96	18956
0.0449	0.383	1.139	81.33	28.93	18956
0.0449	0.458	1.139	128.51	28.93	24483
0.0565	0.458	1.435	128.51	36.45	24483
0.0565	0.556	1.435	202.73	36.45	31346
0.0712	0.556	1.808	202.73	45.93	31346
0.0712	0.682	1.808	318.99	45.93	39894
0.0897	0.682	2.278	318.99	57.87	39894
0.0897	0.843	2.278	499.90	57.87	50578
0.1130	0.843	2.871	499.90	72.91	50578
0.1130	1.322	2.871	778.69	72.91	63958
0.1424	1.322	3.617	778.69	91.86	63958
0.1424	2.079	3.617	1202.18	91.86	80751
0.1794	2.079	4.557	1202.18	100.00	80751
0.1794	3.280	4.557	1832.55	300.00	80751
0.2260	3.280	5.741	1832.55		

Payload Interface Force Method

Verification of the vibratory requirements shall be by analysis or test. Acceptable methods for performing vibration test are contained in SSP 57010, Appendix E (Microgravity Control Plan).

The following sequence is to be used to verify SAR compliance with FCF-SPC-0004, paragraph 3.2.6.4.2 k:

1. Obtain disturbance forces in Force Spectral Density (FSD) for each one-third octave.
2. Calculate rms force magnitude within each one-third octave at each payload attachment interface as the RSS of X, Y, and Z components (rms force) in each one-third octave band.

$$\mathrm{Frms} = \left(\sum_{N} H(f)^2 \cdot \mathrm{FSD}(f)\right)^{\frac{1}{2}}$$

This is to be calculated by combining N frequency subdivisions of each one-third octave per the following equation:

Where H (f) is the transfer function in lb/lb obtained by the FEM model for each frequency subdivision and FSD (f), is the Force Spectral Density forcing function for each frequency subdivision. The appropriate analytical model shall include the effects of the integrated payload rack and its attachments using a Payload Project Office provided interface model.

3. Find the combined force from all payload attachment interfaces as the RSS of all interface point forces (the results of A above) summed over each one-third octave bands.
4. Compare the combined force with the force limits in Figure 21. The wide-band limit may be used if the peak/average ratio is less than 5, otherwise the narrow-band peak limit must be used.

Verification is successful when the analysis or test results show that the interface forces are less than the limits specified in FCF-SPC-0004, paragraph 3.2.6.4.2 k.

Adjacent ARIS Payload Acceleration Method

Verification by this technique requires that SAR determine the ARIS interface accelerations resulting from the worst case combination of payload disturbance sources. This method is applicable for SAR. Application of this method requires integration of an ISS Payload Office provided interface model with payload developer FEM and/or SEA models. Verification of ARIS accelerations is to be performed by the following steps:

7. Obtain disturbance forces in Force Spectral Density (FSD) for each one-third octave.
8. Calculate rms acceleration magnitude within each one-third octave at each payload attachment interface as the RSS of X, Y, and Z components (rms acceleration) in each one-third octave band. This is to be performed using unit forces applied in the X,Y, and Z direction separately. The X, Y, and Z components for each direction as a transfer function are to be calculated for all frequencies of interest. The FSD is to be applied to each transfer function yielding force magnitude (RSS of the real and imaginary component) and the RSS of the acceleration magnitude is to be calculated for each 1/3rd octave by combining N frequency subdivisions of each one-third octave per the following equation:

$$\mathrm{Arms} = \left(\sum_{N} H(f)^2 \cdot \mathrm{FSD}(f)\right)^{\frac{1}{2}}$$

Where H (f) is the transfer function in μg/lb obtained by the FEM model for each frequency subdivision and FSD (f), is the Force Spectral Density forcing function for each frequency subdivision.

3. Find the combined acceleration from all payload attachment interfaces as the RSS of all interface point accelerations (the results of A above) summed over each one-third octave bands.

If the source direction is unknown then the largest response envelope resulting from applying the magnitude in each axis is to be determined. Verification will be considered successful if the rms Average of accelerations at the ARIS interface points from all sources, at all interface points, and all axis does not exceed the limits defined in Table XII.

The following equation describes this summation process:

$$\mathrm{Asum} = \left[\frac{\sum\limits_{\mathrm{Np}} \sum\limits_{(\mathrm{X,Y,Z})} \sum\limits_{\mathrm{Ns}} \mathrm{Amag}^2}{\mathrm{Np}} \right]^{0.5}$$

Where:
Amag is the X, Y, or Z magnitude of model output acceleration at each interface point
Ns is the number of sources
Np is the number of ARIS interface points
Asum is the rms acceleration to be compared with Table XII for each one-third octave.

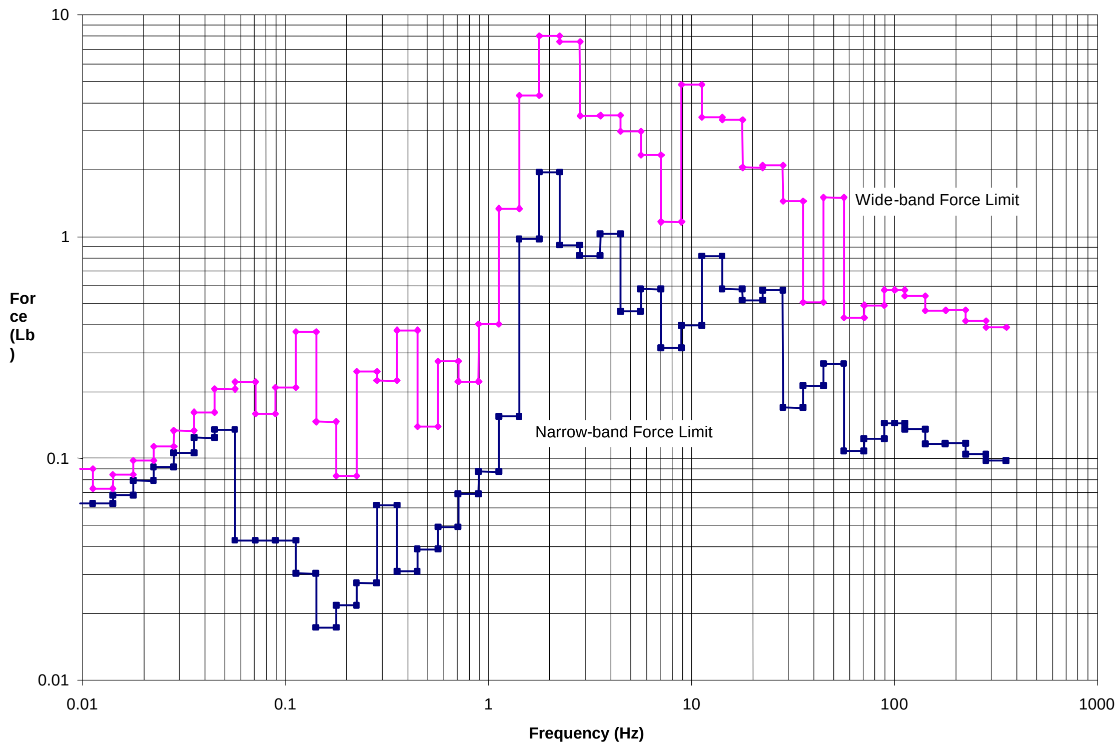


FIGURE 21. Allowable one-third octave interface forces for integrated racks and non-payloads, 0.5% damping factor

l. Verification of maximum transient impulse shall be by analysis or test. Acceptable test methods are defined in SSP 57010, Appendix E. Verification shall be considered successful when the impulse delivered by an integrated rack or non-rack payload over any 10 second period is shown to be less than 10 lb s (44 N s) and when the sum of the impulse and vibration resulting from the impulse do not exceed the vibratory limits of FCF-SPC-0004, paragraph 3.2.6.4.2 k over any 100 second period. FEM time domain analysis is an acceptable verification method for this requirement as defined in FCF-SPC-0004, 4.2.6.4.2 k. Acceleration or force response test data is acceptable if interface impedance considerations are included, including adjustment for possible modal frequency shift and interface structural amplification or attenuation.

m. The maximum force at the integrated rack or non-rack payload interface, as determined by either analysis or test, shall be less than 1000 lb (4448 N) in any direction. Rigid body analysis may be used if it can be shown that the rigid payload force to a rigid interface will not exceed 500 lb (2224 N). Otherwise, FEM payload analysis using a Payload Project Office supplied ISS model must be used to show that the flexible interface force will not exceed 1000 lb (4448 N).

n. The general verification requirements of FCF-SPC-0004, paragraph 4.2.6.4.2 k are applicable. Rigid body assumptions may be made if disturbance frequencies are below the first rack mode. Under baseline ARIS control parameters as used for ISS Stage 5A, the on-board to off-board limits of Figure 22 are most restrictive at low frequencies and the sensor saturation limits are most restrictive at high frequencies. Allowing for the middle frequency range which may affect either requirement, the on-board to off-board analysis may be limited to the low frequency range below 15 and the sensor saturation verification range may be limited to frequencies above 2 Hz. Consequently, based upon assumed payload use of the standard ARIS control parameters, verification may be simplified to meeting the following processes:

Rigid Body Analysis Method

Assuming that the first free-free ARIS mode is greater than 17 Hz, rigid body analysis is sufficient using payload mass properties and known disturbance forces. Effective ARIS interface force shall be calculated by the following method:

1. Obtain frequency domain representations of all input forces by direction and one-third octave. This is to include both narrow-band sources and wide-band sources and the 100 second rms frequency domain representation of transients.
2. Obtain the effective forces due to moments by dividing each moment by the characteristic distance for the moment direction. The characteristic distances are 3 ft (0.91 m) for moments about the rack X and Y axis, and 1.50 ft (0.46 m) for moments about the rack Z axis.
3. The forces and effective forces are to be summed by RSS in the frequency domain of force and effective force by axis.
4. The results are to be summed by RSS of the contribution along each axis in the frequency domain.
5. Compare the results against the allowable limits of Table XIII. The wide-band limit may be used if the peak/average ratio is less than 5, otherwise the narrow-band peak limit must be used.

FEM Analysis Method

If the ARIS payload has modes below 17 Hz under operational free-free conditions then FEM analysis will be required. FEM analysis shall be performed using the following method:

1. Obtain frequency domain representations of all input forces by direction and one-third octave. This is to include narrow-band sources, wide-band sources and the 100 second rms frequency domain representation of transients. If rms input vs. frequency data is used, this is to be converted to Frequency Spectral Density (FSD) by guideline 6 of 4.3.1.2.2.
2. Determine the acceleration response at each ARIS actuator interface point and at the center of the umbilical panel.
3. The accelerations are to be summed for each one-third octave as the RSS of all frequencies within each one-third octave by the following equation:

$$\mathrm{Arms} = \left[\sum_{(x,y,z)} \sum_{N} A(d,n)^2 \right]^{\frac{1}{2}}$$

   Where A (d, n) is the acceleration by direction (d) and interface point (n).

4. Compare the results against the allowable limits of Table XIII. The wide-band limit may be used if the peak/average ratio is less than 5. Otherwise the narrow-band peak limit must be used.

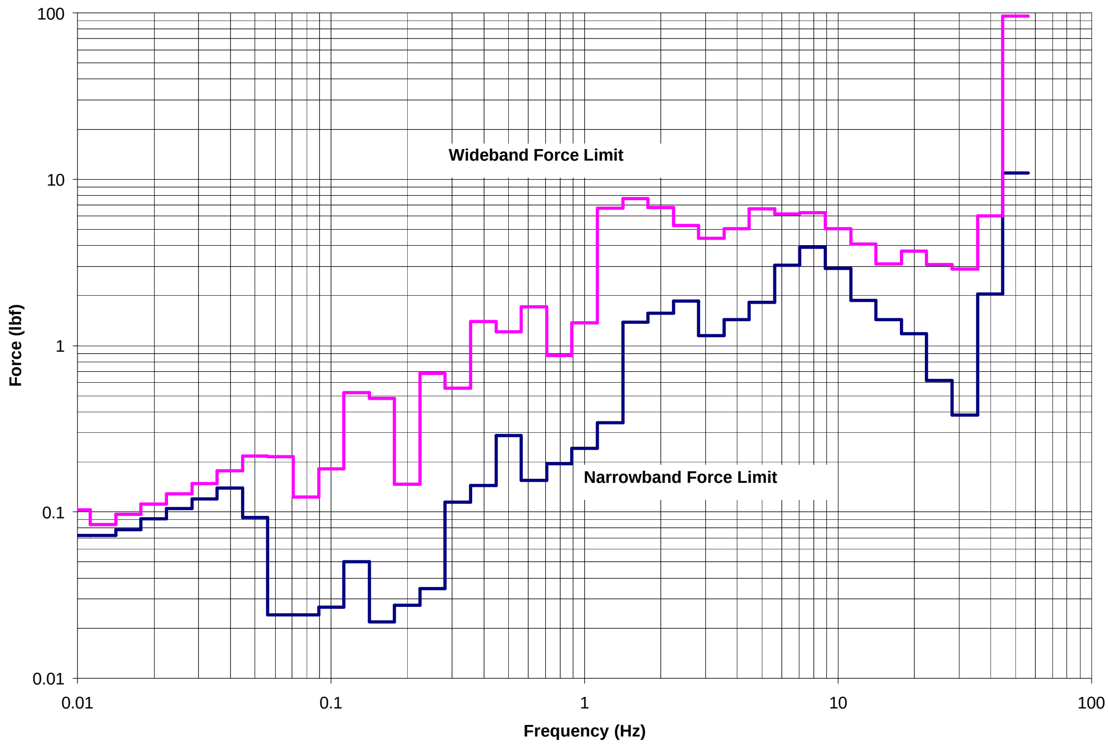


FIGURE 22. Allowable on-board force values for ARIS integrated payloads to meet off-board limits

TABLE XIII. Allowable on-board force values for ARIS integrated payloads to meet off-board limits

Freq. (Hz.)	NBP Limit (lbf)	WB Limit (lbf)	Freq. (Hz.)	NBP Limit (lbf)	WB Limit (lbf)	Freq. (Hz.)	NBP Limit (lbf)	WB Limit (lbf)
0.0089	0.0722	0.1033	0.1778	0.0274	0.1466	3.5480	1.4337	5.0388
0.0112	0.0722	0.1033	0.2239	0.0274	0.1466	4.4670	1.4337	5.0388
0.0112	0.0722	0.0842	0.2239	0.0346	0.6819	4.4670	1.8234	6.6213
0.0141	0.0722	0.0842	0.2818	0.0346	0.6819	5.6230	1.8234	6.6213
0.0141	0.0785	0.0971	0.2818	0.1147	0.5577	5.6230	3.0271	6.2002
0.0178	0.0785	0.0971	0.3548	0.1147	0.5577	7.0790	3.0271	6.2002
0.0178	0.0910	0.1113	0.3548	0.1445	1.3967	7.0790	3.8832	6.2891
0.0224	0.0910	0.1113	0.4467	0.1445	1.3967	8.9130	3.8832	6.2891
0.0224	0.1046	0.1279	0.4467	0.2881	1.2088	8.9130	2.9020	5.0388
0.0282	0.1046	0.1279	0.5623	0.2881	1.2088	11.2200	2.9020	5.0388
0.0282	0.1201	0.1488	0.5623	0.1554	1.7174	11.2200	1.8602	4.0770
0.0355	0.1201	0.1488	0.7079	0.1554	1.7174	14.1300	1.8602	4.0770
0.0355	0.1392	0.1763	0.7079	0.1945	0.8709	14.1300	1.4350	3.0919
0.0447	0.1392	0.1763	0.8913	0.1945	0.8709	17.7800	1.4350	3.0919
0.0447	0.0926	0.2167	0.8913	0.2416	1.3743	17.7800	1.1754	3.7060
0.0562	0.0926	0.2167	1.1220	0.2416	1.3743	22.3900	1.1754	3.7060
0.0562	0.0240	0.2147	1.1220	0.3449	6.7131	22.3900	0.6179	3.0764
0.0708	0.0240	0.2147	1.4130	0.3449	6.7131	28.1800	0.6179	3.0764
0.0708	0.0240	0.1225	1.4130	1.3847	7.6318	28.1800	0.3821	2.9013
0.0891	0.0240	0.1225	1.7780	1.3847	7.6318	35.4800	0.3821	2.9013
0.0891	0.0269	0.1820	1.7780	1.5667	6.7883	35.4800	2.0342	6.0143
0.1122	0.0269	0.1820	2.2390	1.5667	6.7883	44.6700	2.0342	6.0143
0.1122	0.0502	0.5226	2.2390	1.8464	5.2891	44.6700	10.9057	96.2593
0.1413	0.0502	0.5226	2.8180	1.8464	5.2891	56.2300	10.9057	96.2593
0.1413	0.0218	0.4830	2.8180	1.1511	4.4228			
0.1778	0.0218	0.4830	3.5480	1.1511	4.4228			

4.6.4.3 Electrical requirements.

4.6.4.3.1 Steady-state voltage characteristics.

The SAR at Interface B steady-state voltage requirements shall be verified by test. Verification of compatibility with steady-state voltage limits shall be performed by test at low and high input voltage values of 116 to 126 Vdc. The EPCE shall be operated under selected loading conditions that envelope the operational loading. The verification shall be considered successful when the test shows under low and high voltage conditions the EPCE is compatible with the steady-state voltage limits of 116 to 126 Vdc. Verification may be performed by the PRCU or equivalent.

4.6.4.3.2 Ripple voltage characteristics.

a. Ripple voltage and noise requirements shall be verified by analysis. The verification shall be considered successful when the CS–01 test shows the SAR connected to Interface B and EPCE operate and are compatible with the EPS time domain ripple voltage and noise level of at least 2.5 Vrms within the frequency range of 30 Hz to 10 kHz.
b. Ripple voltage spectrum requirements shall be verified by analysis. Verification shall be considered successful when analysis of the CS–01 and CS–02 test data shows the SAR

connected to Interface B and EPCE operates and is compatible with the ripple voltage spectrum in Figure 23.

4.6.4.3.3 Transient voltages.

Transient voltage requirements shall be verified by test or analysis. Input voltage shall be 116 Vdc and 126 Vdc with the Interface B source impedance, as specified in SSP 30482 Volume I. Verification of compatibility with the specified transient voltages shall be performed by test or analysis of SAR operation across the transient envelope as specified in Figure 24 of this document. The verification shall be considered successful when the test or analysis shows the SAR is compatible with the EPS transient voltage characteristics as specified in Figure 24.

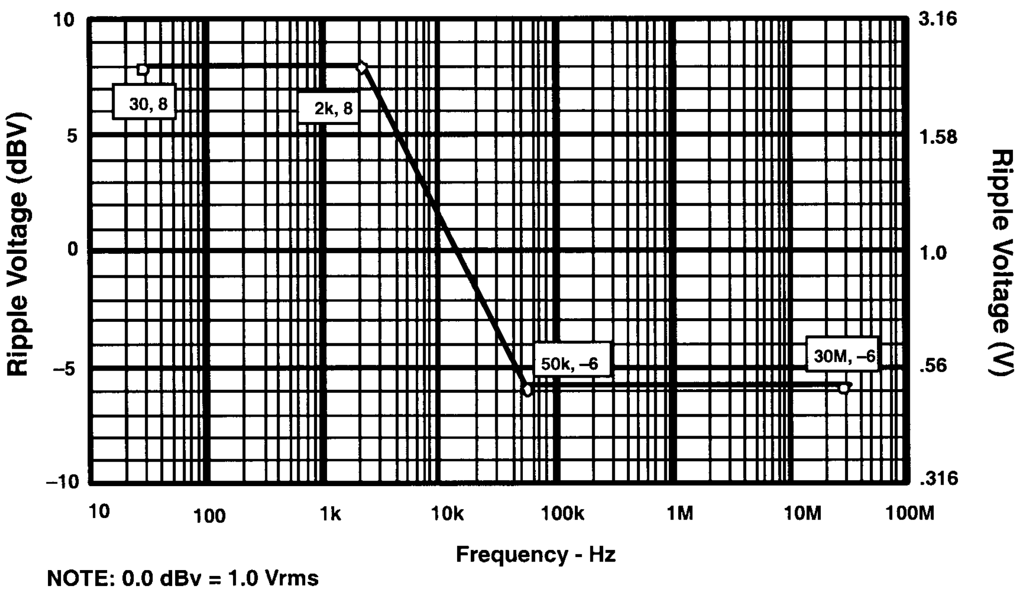


FIGURE 23. Maximum Interfaces B and C ripple voltage spectrum

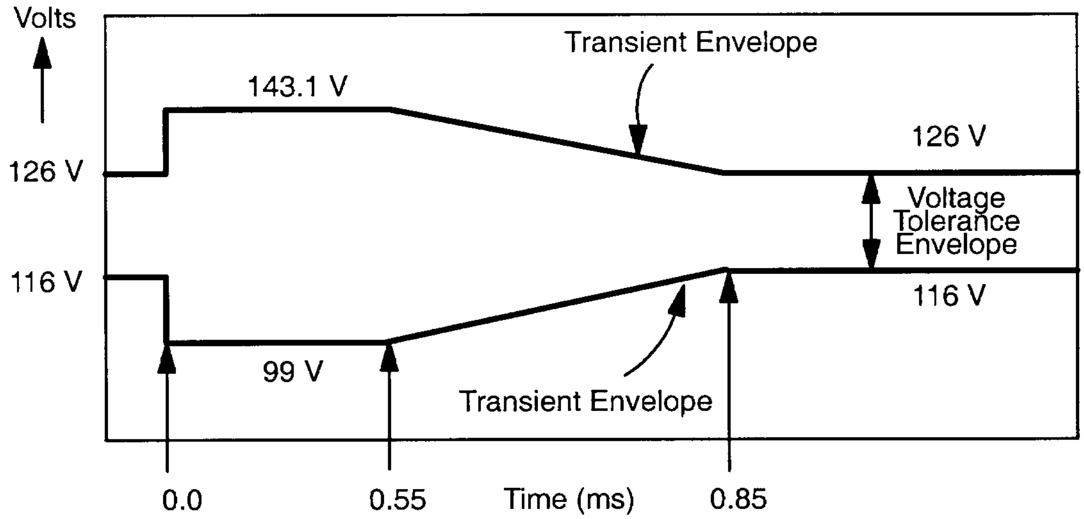


FIGURE 24. Interface B voltage transients

4.6.4.3.4 Fault clearing and protection.

Fault clearing and protection shall be verified by analysis. The verification shall be considered successful when analysis shows the SAR at Interface B does not produce an unsafe condition or one that could result in damage to ISS equipment or payload hardware from the EPS transient voltages as specified in Figure 25 of this document.

4.6.4.3.5 Non-normal voltage range.

Verification of compatibility with non-normal voltage range conditions shall be performed by analysis. The analysis shall ensure the SAR or EPCE will not produce an unsafe condition or one that could result in damage to ISS equipment external to the SAR or EPCE when parameters are non-normal voltage characteristics of a maximum overvoltage of + 165 Vdc for 10 s and undervoltage conditions of +102 Vdc for an indefinite period of time. The analysis should be performed with all converters directly downstream of Interface B. The verification shall be considered successful when analysis shows the SAR or EPCE is safe within ISS interface conditions.

4.6.4.3.6 Power bus isolation.

a. Verification of power bus isolation between two independent ISS Power Buses as specified shall be performed by analysis. The verification shall be considered successful when the analysis shows the SAR, with a source voltage of + 126 Vdc, and its internal and external EPCE provides a minimum of 1-MΩ isolation in parallel with not more than 0.03 µF of mutual capacitance between the two independent power buses including both the supply and return lines.
b. Verification of power bus isolation without the use of diodes shall be verified by analysis. The analysis shall show the exclusion of diodes used to isolate the two independent ISS power bus high side or return lines. The verification shall be considered successful when

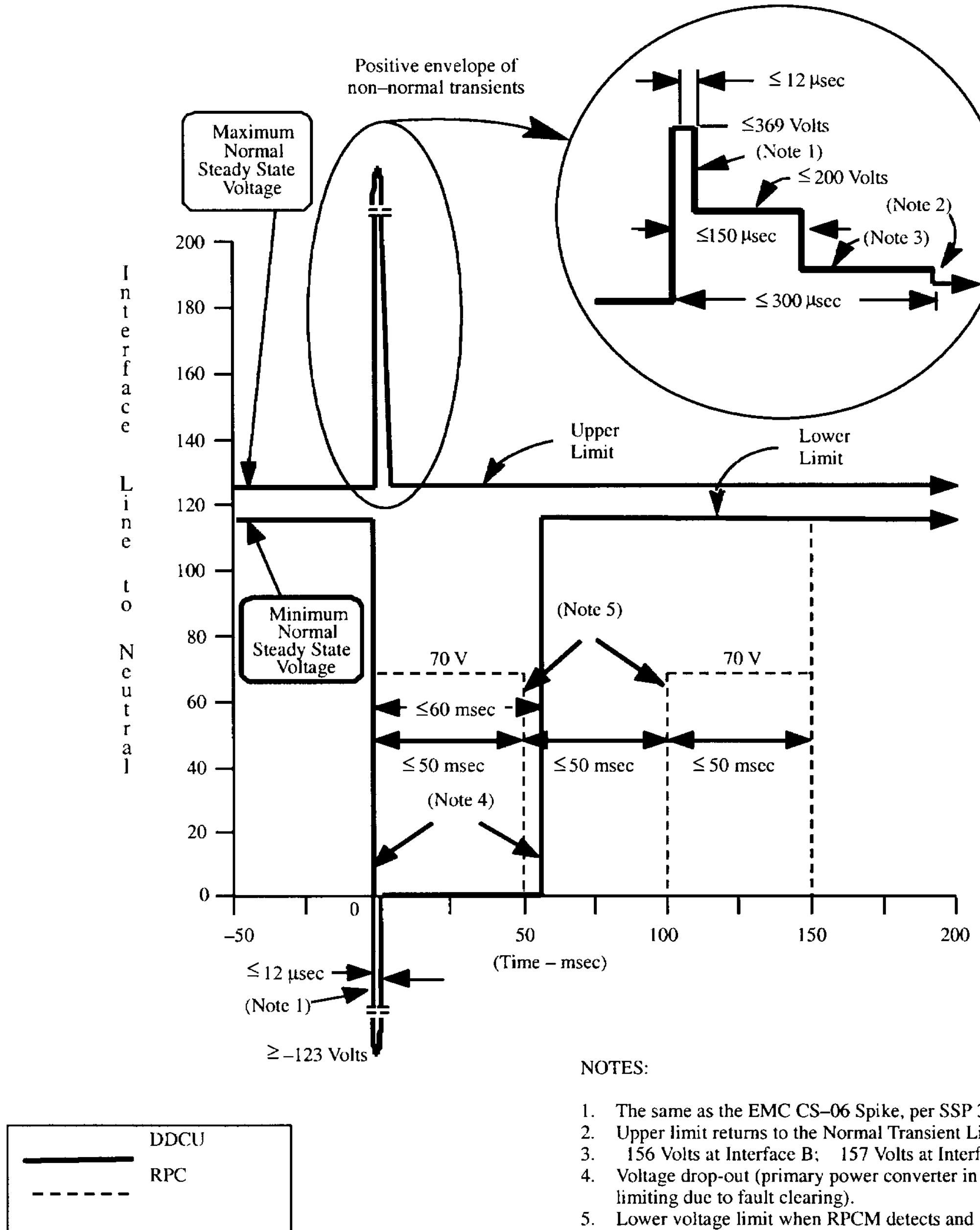
analysis shows there are no diodes used, to electrically tie together independent ISS power bus high side or return lines, within the SAR and its internal and external EPCE.

4.6.4.3.7 Compatibility with soft start/stop remote power controller (RPC).

Compatibility with soft start/stop RPC(s) shall be verified by test. Verification of initialization with soft start/stop performance characteristics shall be performed by test when the initial supply of power is provided to the equipment connected to the RPC(s). Input power to the payload EPCE shall be delivered though a PRCU or equivalent. The EPCE connected to Interface B shall be operated with multiple load combinations at levels ranging from 0 to 100% of the RPC rated conductivity. The verification shall be considered successful when test shows the EPCE can initialize operation and prove compatibility with the soft start/stop RPC characteristics, representative of Figure 26.

4.6.4.3.8 Surge current.

Surge current shall be verified by test and analysis. Input power to the SAR or EPCE should be representative of the ISS power environment. Verification of compatibility with surge current limits shall be performed by test at high, nominal, and low input voltage values as specified. The power source used to perform the test shall be capable of providing a range of power between 0 to 6 kW at 116–126 Vdc for Interface B connected equipment. The EPCE shall be operated under selected loading conditions that envelope the operational loading. The analysis shall be performed using test data from the above test. The analysis shall indicate operability and compatibility exist based on test data and the requirements specified in FCF-SPC-0004, paragraph 3.2.6.4.3.8. The verification shall be considered successful when test and analysis shows under high, nominal, and low voltage conditions the EPCE can perform all functional capabilities and prove compatibility by operating within the specified limits of FCF-SPC-0004, paragraph 3.2.6.4.3.8.



NOTES:

1. The same as the EMC CS–06 Spike, per SSP 30237.
2. Upper limit returns to the Normal Transient Limit.
3. 156 Volts at Interface B; 157 Volts at Interface C.
4. Voltage drop-out (primary power converter in current limiting due to fault clearing).
5. Lower voltage limit when RPCM detects and responds to under voltage conditions.

FIGURE 25. Fault clearing and protection transient limits

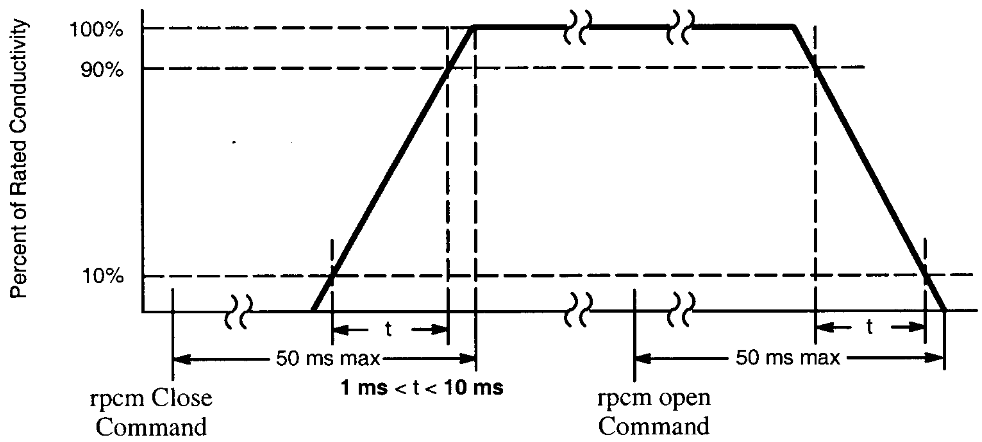


FIGURE 26. US RPC soft start/stop characteristics

4.6.4.3.9 Reverse energy/current.

Reverse energy/current shall be verified by analysis. Input power to the SAR or EPCE should be representative of the ISS power environment. Verification of compatibility with reverse energy/current limits shall be performed by analysis at 6 kW, 3 kW, or 1.44 kW values corresponding to the SAR or EPCE design. The power source used to perform the analysis shall be capable of providing a range of power between 0 and 6 kW at 116–126 Vdc for Interface B connected equipment. The EPCE shall be analyzed under selected loading conditions that envelope the operational loading. The verification shall be considered successful when analysis shows that the SAR or EPCE complies with requirements defined in Table XIV for the reverse energy/current into the upstream power source. Also, when the reverse energy or the reverse current requirement for all environmental conditions specified in this document when powered from a voltage source with characteristics specified in SSP 57000, paragraphs 3.2.1and 3.2.2.4 when a source impedance of 0.1 Ω is met.

TABLE XIV. Maximum reverse energy/current from downstream loads

ISPR INTERFACE Power/RPCM type	MAXIMUM REVERSE ENERGY (Joules)	MAXIMUM REVERSE CURRENT (amps)		
		Pulse t < 10 μs	Peak t < 1 ms	Steady State t > 1 s
3 kW / type VI	3.0	400	250	3
6 kW / type III	6.0	800	500	6
JEM	**(TBD #7)**	**(TBD #7)**	**(TBD #7)**	**(TBD #7)**
ESA	**(TBD #8)**	**(TBD #8)**	**(TBD #8)**	**(TBD #8)**
UOP Type 1	1.5	400	250	2
UOP Type V	1.5	400	250	2
μs = microseconds ms = milliseconds s = second				

4.6.4.3.10 Current protection devices.

a. Tests shall be performed to show the SAR connected to an Interface B ISPR location operates and is compatible with the characteristics shown and described in SSP 57001, paragraph 3.2.6, Figures 3.2.6–1, 3.2.6–2, and 3.2.6–3. The tests shall be performed at initiation of power to the SAR and with multiple internal load combinations that include, but are not limited to sub-rack payloads. The verification shall be considered successful if the test results show the initial current flow, when powered “on,” to the SAR and current flow during the SAR operations with multiple internal load combinations including sub-rack payloads does not exceed the current magnitude and duration as defined and described in SSP 57001, paragraph 3.2.6, Figures 3.2.6-1, 3.2.6-2, and 3.2.6-3.
b. Analysis of electrical circuit schematics shall be performed to show overcurrent protection exists at all points in the payload electrical architecture system where power is distributed to lower level (wire size not protected by upstream circuit protection device) feeder and branch lines. The analysis shall be considered successful when results show overcurrent protection exists at each point in the payload electrical architecture system where power is distributed to lower level (wire size) feeder and branch lines.
c. Analysis of electrical circuit schematics shall be performed to show current limiting overcurrent protection exists for all internal loads drawing power from an Interface B power feed(s). The analysis shall be considered successful when results show current limiting overcurrent protection exists in the distribution paths to all load devices connected to an Interface B power feed(s).

4.6.4.3.11 SAR trip ratings.

The SAR trip ratings shall be verified by test and demonstration. Input power to the integrated rack or EPCE should be representative of the ISS power environment. The test and demonstration shall be performed as specified in paragraph 4.6.4.3.10. The verification shall be considered successful when test and demonstration shows the requirements specified in paragraph 4.6.4.3.10 are met.

4.6.4.3.12 Interface B complex load impedances.

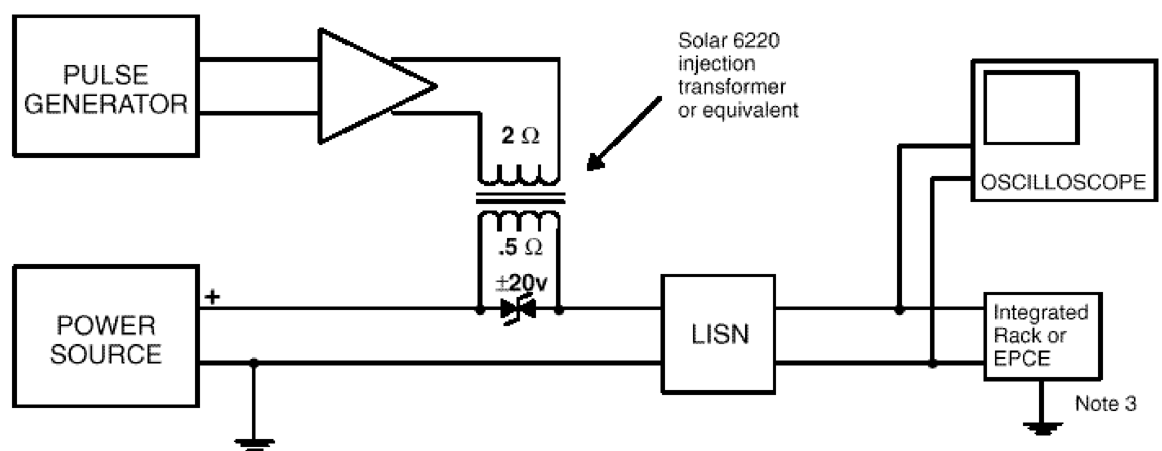
The following verification requirements apply to FCF-SPC-0004, subparagraphs 3.2.6.4.3.12 a and b. SAR complex load impedance(s) shall be verified by test. Verification may be performed by the PRCU or equivalent only if the PRCU or equivalent meets SSP 30482 Volume 1, Rev. C source impedance requirements. All active converters directly downstream of Interface B shall be qualification or flight hardware. Loading of the downstream converter(s) can be simulated to provide full range of active converter loading. Load impedance shall be tested under conditions of high, nominal, and low voltage to the SAR and with these conditions for the active converters directly downstream shall be exercised through the complete range of their loading. Selected combinations of converters that can influence the measured load impedance at Interface B shall be tested. The verification shall be considered successful when the test shows that all load impedances measured for high, nominal, and low voltage conditions remain within specified limits.

4.6.4.3.13 Large signal stability.

Large signal stability shall be verified by test and analysis. A large signal stability test shall be conducted for the integrated rack connected to Interface B. An integrated analysis shall be provided by the SAR integrator for representative maximum and minimum case loads to demonstrate that impedance variations will not impact system stability. The input and transient response waveform for the SAR and EPCE shall be recorded from the start of the pulse through the time when the transient diminishes to and remains below 10% of the maximum amplitude of the response.

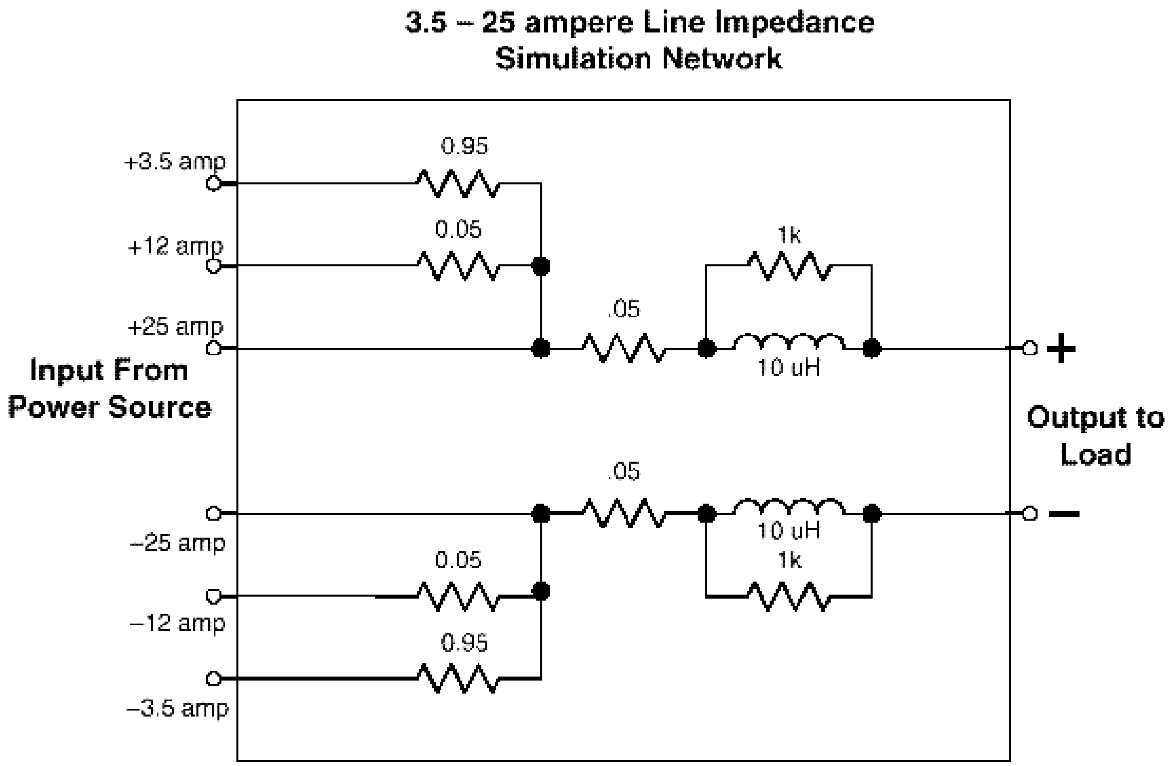
The required test conditions may be produced using a programmable power source or the setup shown in Figure 27. The 25 amp and 50 amp LISN or equivalent is to be used for integrated racks connecting to Interface B and the 12 amp LISN or equivalent is to be used for EPCE connecting to Interface C as shown in Figure 28. The pulse generator/amplifier must provide a source impedance of less than 0.2 Ω from 100 Hz to 10 kHz to the 2 Ω load of the primary side of the pulse transformer. Pulses of 100, 125, and 150 μs (±10 μs) duration shall be applied. The pulse amplitude at the secondary side of the injection transformer should be between 10 and 15 V. Pulse rise and fall times must not exceed 10 μs between 10 and 90% of the pulse amplitude. The resulting transient responses must remain within the EPS normal transient limits.

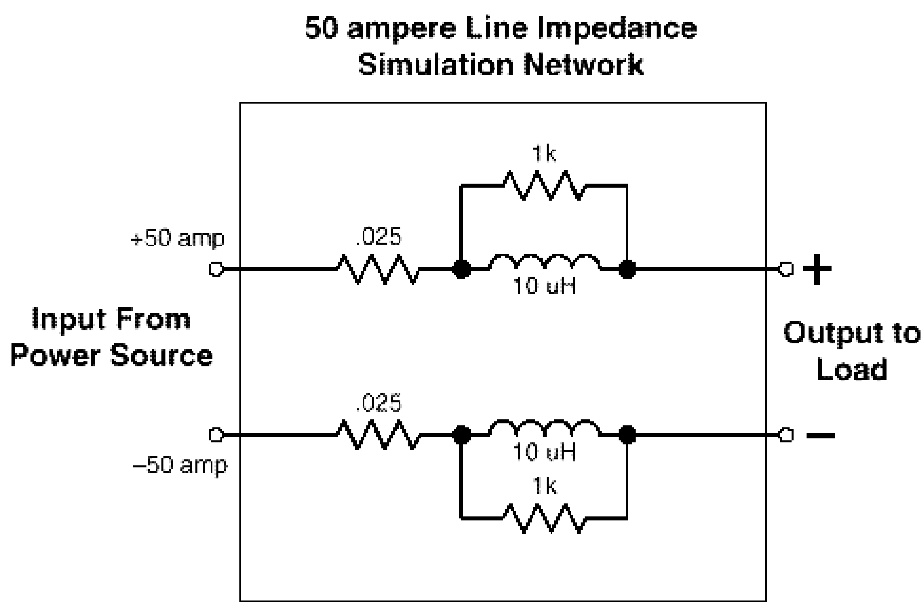
The test and analysis shall be considered successful when results show transient responses, measured at the input to SAR or EPCE, diminish to 10% of the maximum amplitude within 1.0 ms and remain below 10% thereafter.



NOTES:
1. The output of the pulse generator must be applied to the transformer through a drive amplifier capable of providing an output impedance of 0.2 ohms, or less, from 100 Hz to 10 kHz.
2. The drive amplifier should be capable of delivering at least 75 watts rms into a 4 Ohm load and be suitable for EMC CS–01 tests.
3. Chassis of integrated rack must be grounded; portable equipment is not grounded.
4. Pulse generator, injection transformer and Zener diode may require adjustment to generate the test pulses and to protect the integrated rack or EPCE under test.

FIGURE 27. Stability test setup, transient responses





Note: Resistance is in Ohms

FIGURE 28. ISS line impedance simulation network (LISN)

4.6.4.3.14 Maximum ripple voltage emissions.

Maximum ripple voltage emissions shall be verified by test and analysis. Maximum ripple voltage induced on each of the power lines by the SAR and EPCE connected to Interface B shall be verified by test using the CE–07 test configuration of SSP 30238 (measured with a 20 MHz bandwidth instrument). Maximum ripple voltage for the on-orbit configuration of the SAR shall be verified by analysis of test data from individual EPCE test results. The verification shall be considered successful when:

1. Test shows the SAR and EPCE does not induce voltage levels, at or upstream of Interface B, greater than 0.5 V peak-to-peak from supply to return line.
2. Analysis of test data shows the on-orbit configuration of the SAR does not induce voltage levels at or upstream of Interface B, greater than 0.5 V peak-to-peak from supply to return line.

Note: Measurement of transients, as defined in SSP 30237 CE–07, is not required in this test procedure.

4.6.4.3.15 Wire derating.

a. Wire derating for the EPCE at and downstream of the primary circuit protection device(s) in the SAR shall be verified by analysis. Analysis of the electrical power schematics shall be performed to show that the wire gauge of the SAR and EPCE meets the requirements as specified in Figure 29. The verification shall be considered successful when the analysis shows the SAR and EPCE meet the wire derating requirements as specified in NASA Technical Memo (TM) 102179 as interpreted by NSTS 18798, TA–92–038. Wire gauge meeting the requirements of SSP 30312 is accepted as meeting the requirements of NASA Technical Memo (TM) 102179 as interpreted by NSTS 18798, TA–92–038.
b. Wire size for the wire/cable from UIP to the primary circuit protection device(s) in the SAR shall be verified by inspection or analysis. Inspection or analysis of cable drawings shall be performed to show that the wire gauge uses 4 gauge wire for main and auxiliary connections at the UIP. The verification shall be considered successful when the inspection or analysis shows that 4 gauge wires are used for main and auxiliary connections from UIP to the primary circuit protection device(s) in the SAR.

4.6.4.3.16 Exclusive power feeds.

The exclusive power feeds requirement shall be verified by analysis of electrical circuit schematics. The analysis shall be considered successful when the electrical schematics show:

a. The SAR only receives power from the UIP dedicated to its rack location.
b. Cabling does not occur between Interface C connected EPCE with Interface B; and/or Interface B connected EPCE with Interface C.

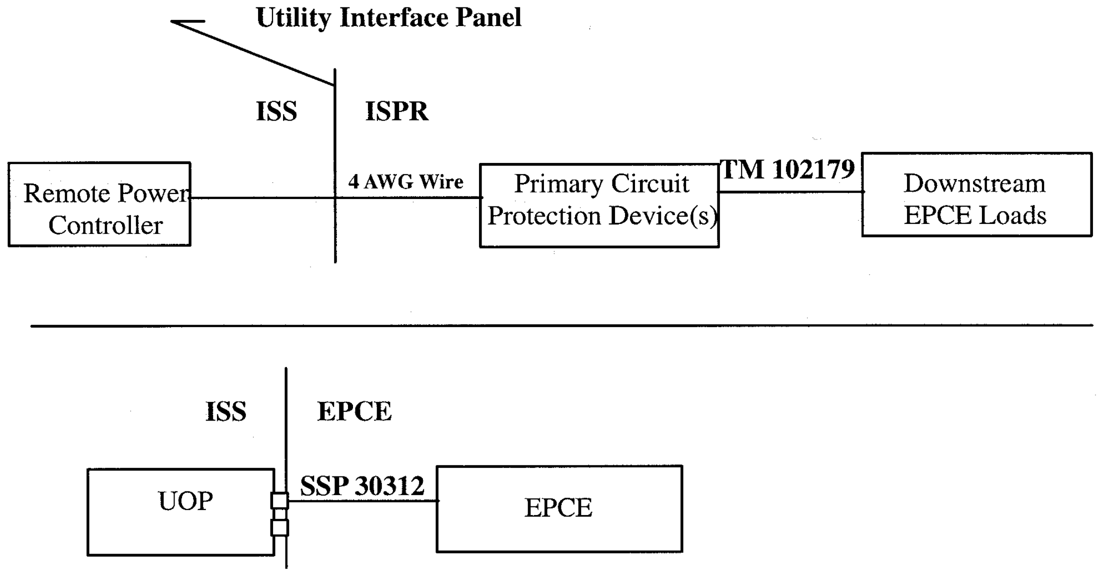


FIGURE 29. Wire derating requirements for SAR

4.6.4.3.17 Loss of power.

Verification that the equipment connected to Interface B meets the loss of power safety requirements specified in NSTS 1700.7, ISS Addendum shall be verified by test and submitted to the Payload Safety Review Panel (PSRP) in accordance with NSTS 13830. Verification shall be considered successful when hazard reports and safety data presented to the PSRP during the phased safety reviews are approved.

4.6.4.3.18 Electromagnetic compatibility.

The electromagnetic compatibility (EMC) of the SAR EPCE shall be verified by test, analysis, and/or inspection. The test shall be considered successful when the results show that the SAR EMC is in compliance with the requirements of SSP 30243, paragraphs 3.1, 3.5, and 3.6.2. The analysis shall be based on end item qualification data and SAR EPCE design and analysis data. The analysis shall be considered successful when the data shows the SAR EPCE meets the EMC requirements of SSP 30243, paragraphs 3.1, 3.5, and 3.6.2. The inspection shall be based on physical/visual indications of the SAR EPCE. The inspection shall be considered successful when physical/visual indications show the EMC requirements of SSP 30243, paragraph 3.1, 3.5, and 3.6.2 are met. The requirements of SSP 30243, paragraphs 3.1 and 3.6.2 shall be verified by test and analysis. The test shall be considered successful when results show the SAR connected to Interface B meets the requirements specified in SSP 30243, paragraph 3.6.2. The results of the EMC test shall be documented in the EMC test plan/report. The analysis shall be documented in an EMC Control Plan and Design Analysis Report. The analysis shall include determining the necessary requirements for equipment not connected directly to Interface B such that the entire payload meets the EMC requirements of SSP 57000. The analysis shall be considered successful when results show that the requirements defined in paragraph 3.1 of SSP 30243 have been met.

Note:
1. The Control Plan and the Design Analysis Report can be combined into one document per payload provider format.
2. Clarifications to SSP 30243, paragraph 3.6.2:
    a. Only the impedance characteristics of the power source need to be simulated.
    b. Only representative simulated signals and loads for the interface tests are required.
    c. Verification of the on-orbit configuration of the integrated rack may be performed analytically if and only if the on-orbit configuration differs from the Qualification Test configuration.
3. Details of the EMC Control Plan, Design Analysis Report, and EMC Test Plan/Report are located in SSP 57010.
4. If analysis shows requirements of paragraph 3.6.2 of SSP 30243 are met during SAR or multiple EPCE EMI testing, as defined SSP 30237, a separate EMC test plan/report is not needed.

4.6.4.3.18.1 Electrical grounding.

The electrical grounding of the SAR EPCE shall be verified by test and analysis. The test shall be considered successful when the results show that SaR grounding is in compliance with the requirements in section 3 of SSP 30240. The analysis shall be based on end item qualification data and SAR EPCE design and analysis data. The analysis shall be considered successful when the data shows the SAR EPCE is electrically grounded within the requirements of section 3 of SSP 30240.

4.6.4.3.18.2 Electrical bonding.

The electrical bonding of the SAR EPCE shall be verified by test, analysis, and inspection. The test shall be considered successful when the results show all requirements of SSP 30245 and the requirements of NSTS 1700.7, ISS Addendum in sections 213 and 220 are met. The analysis shall be based on end item qualification data and SAR EPCE design and analysis data. The analysis shall be considered successful when the data shows the SAR EPCE is electrically bonded within the requirements of SSP 30245 and the requirements of NSTS 1700.7, ISS Addendum in sections 213 and 220 are met. The inspection shall be based on physical/visual indications of the SAR EPCE. The inspection shall be considered successful when physical/visual indications show all requirements of SSP 30245 and the requirements of NSTS 1700.7, ISS Addendum in sections 213 and 220 are met.

4.6.4.3.18.3 Cable/wire design and control requirements.

The cable and wire design of the SAR EPCE external cables shall be verified by test, analysis, or inspection. The test shall be considered successful when the results show all requirements of SSP 30242 are met. The analysis shall be based on SAR EPCE design and analysis data. The analysis shall be considered successful when the results show all requirements of SSP 30242 are met. The inspection shall be based on physical/visual indications of the SAR EPCE. The inspection shall be considered successful when physical/visual indications show that external cable and wire design is in compliance with the requirements of SSP 30242. SSP 30242 harness requirements can normally be met by inspection of drawings and hardware. Analysis is required to classify signals and determine the necessary isolation between signals. Test may be required to determine impedance and sensitivity characteristics of the circuit when classification cannot be determined by examination of the circuit known characteristics.

4.6.4.3.18.4 Electromagnetic interference.

The electromagnetic interference of the SAR EPCE shall be verified by test and analysis. Tests shall be performed and data submitted for conducted susceptibility and radiated susceptibility, in addition to that for conducted emissions and radiated emissions. This data shall be evaluated against the limits of SSP 30237. The test results shall be documented in the EMI test plan/report. The test shall be considered successful when the results show requirements of SSP 30237 are met.

Note: EMI test plan/report details are located in SSP 57010.

The analysis of the SAR shall be performed using SAR assembly equipment test data as mentioned in the above paragraph. The analysis shall be considered successful when the results show requirements of SSP 30237 are met. This analysis includes evaluating the degree of isolation from 30 Hz to 400 MHz provided by the EPCE for power ripple and transients to the equipment using isolated power. An analysis of the isolation in conjunction with the equipment conducted requirements should be submitted in the EMC Control Plan to verify the requirements of SSP 57000 are met. The EMI test methods shall be as specified in SSP 30238.

4.6.4.3.18.5 Electrostatic discharge.

The susceptibility of the electrostatic discharge (ESD) of the unpowered SAR EPCE and its components shall be verified by test or analysis and inspection. The analysis shall be based on SAR EPCE design and analysis data. The test or analysis shall be considered successful when the results show the unpowered SAR and its components shall not be damaged by ESD equal to or less than 4,000 V to the case or any pin on external connectors. EPCE that may be damaged by ESD between 4,000 and 15,000 V shall have a label affixed to the case in a location clearly visible in the installed position. The inspection shall be based on physical/visual indication of the payload EPCE.

4.6.4.3.18.6 Alternating current (ac) magnetic fields.

The ac magnetic fields requirement for the SAR connected to Interface B, including cables and interconnecting wiring, shall be verified by test. The test shall be performed using the MIL–STD–462D RE01 Method with the following modifications:

1. Test setup guidelines shall be per SSP 30238, Figure 3–9 or 3–10, not the setup identified by MIL–STD–462D.
2. Guidelines of SSP 30238, Figures 3–9 and 3–10, requirement of 1 m separation does not apply to RE01.
3. Measurements are required from 30 Hz to 50 kHz rather than 100 kHz required by MIL–STD–461D.

4. Measurements are performed at 7 cm from the generating equipment. In the event emissions are out-of-specification, measurements are performed at 50 cm from the generating equipment.
5. Emissions greater than 20 dB below the specified limits shall be recorded in the EMI test report. In cases where the noise floor and ambient are not 20 dB below specified level, only those emissions above the noise floor/ambient are required to be recorded.

The verification shall be considered successful when test results show the generated ac magnetic fields of the SAR connected to Interface B, including cables and interconnecting wiring, do not exceed 140 dB above 1 pT between 30 Hz to 2 kHz, and the fall off is no less than 40 dB per decade to 50 kHz.

4.6.4.3.18.7 Direct current (dc) magnetic fields.

The dc magnetic fields requirement for the SAR connected to Interface B with electromagnetic and/or permanent magnetic devices shall be verified by test or analysis. The measurement or analysis of dc magnetic fields shall be performed at 7 cm from the generating equipment. For integrated racks and EPCE that exceed the design requirement, measurements or analysis at 10 cm from the generating equipment shall be performed if there is a dc magnetic field greater than 170 dB above 1 pT. Additional measurements or analyses shall be performed at 10 cm increments away from the generating equipment until data proves the dc magnetic fields are 6 dB below the 170 dB above 1 pT requirement. The verification shall be considered successful when test or analysis results show the generated dc magnetic fields of the SAR connected to Interface B do not exceed 170 dB above 1 pT at a distance of 7 cm from the generating equipment, including electromagnetic and permanent magnetic devices.

4.6.4.3.18.8 Corona.

Equipment with voltages (steady-state, transient, internal, or external) greater than 190 V or equipment containing gases mixture other than those present in the pressurized module shall be verified by analysis or test to the degree necessary to ensure no permanent damaging effects and no hazardous conditions due to destructive corona will exist in its operating environment. The operating environment is defined as normal pressurized atmosphere as specified in Table V or depressurized module if the payload is still powered. If the equipment (with voltages greater than 190 V) may be powered during depressurization, the verification shall be by test.

4.6.4.3.18.9 Lightning.

The lightning requirement shall be verified by analysis. The analysis shall be considered successful when the data shows that the SAR and EPCE is compatible with the requirements specified in SSP 30243, paragraph 3.2.8.1. Note: The analysis data should be based on end item qualification design data and analysis data of the SAR or EPCE.

4.6.4.3.18.10 EMI susceptibility for safety-critical circuits.

Safety critical circuits should be verified by test and analysis. The analysis shall be considered successful when the results show the requirements of SSP 30243, paragraph 3.2.3 are met.

4.7 Transportability.

The SAR transportability within the United States without damage by truck or air via common commercial carrier when packaged as specified herein without requiring special accommodation to meet the transportation and handling limit load factors as specified in Table XV shall be verified by analysis. The verification shall be considered successful when the analysis shows that the transportation and handling limit load factors as specified in Table XV are met.

TABLE XV. Transportation and handling limit load factors

Mode	Load Occurrence	Fore/Aft g's	Lateral g's	Vertical g's
Air	I	±3.5	±2.0	+3.5/0.0
Truck/air ride trailer	I	±3.5	±2.0	+3.5/-1.5
Dolly(max velocity 8 km/h (5 mph))	I	±1.0	±0.75	+2.0/-0.0
Forklifting	S	±1.0	±0.75	+2.0/-0.0
Hoisting	I	1.5 in direction of travel		

Notes:
S - Loads occur simultaneously in the three directions.
I – Loads occur independently in the three directions except for gravity.
Above load factors act at the center of gravity of the cargo.
Cargo weighing <136 kgs. Subject to additional loads cause by vibroacoustics for applicable transportation modes.
For ground transportation, the structure/carrier vehicle should be designed for the occurrence of a 15.4 m/s wind in combination with the load factors.
Cargo support structure will be designed, or carrier operation constrained, or both to insure that cargo loads will not exceed the design load.
Limit load factors listed in this table may be superseded by limit load factors derived for specific transportation mode/vehicle, transportation handling fixtures and handling equipment.
Vertical g's are positive in the direction of gravity (downward).

4.7.1 SAR launch and return.

The SAR design, in its launch configuration, and the stowed SAR hardware design to withstand a minimum of two shuttle launches and landings in the MPLM shall be verified by analysis. The verification shall be considered successful when the analysis shows the SAR, in its launch configuration, and the stowed SAR hardware are designed to withstand a minimum of two shuttle launches and landings in the MPLM.

4.8 Design and construction.

4.8.1 Materials, processes, and parts.

4.8.1.1 SAR specific material requirements.

4.8.1.1.1 Materials – general.

Verification that parts and materials meet the requirements of paragraphs 208.3 and 209 of NSTS 1700.7 and NSTS 1700.7, ISS Addendum shall be verified by inspection as specified in FCF-PLN-0036. Verification shall be considered successful when GRC accepts all materials per the requirements of FCF-PLN-0036.

4.8.1.1.2 ITCS Fluids.

a. Verification of fluid physical and chemical characteristics shall be by test. A test shall be conducted according to the verification test requirements specified in SSP 30573, section 4.0 to determine whether or not the fluid contained in the SAR interfacing with the ISS satisfies the fluid physical and chemical characteristics. The verification shall be considered successful if the test results show the SAR fluid physical and chemical characteristics meet the fluid chemistry requirements in SSP 30573.
b. Verification of fluid system cleanliness levels shall be by test. The verification shall be considered successful when samples per SSP 30573, section 4.0 show that fluids in the SAR comply with the cleanliness level requirements specified.
c. Verification of fluid system dissimilar metals compatibility shall be by inspection or analysis. The inspection shall compare the materials and parts list with the materials listed in MSFC-SPEC-250, Table III. Verification success shall be when the inspection of the materials and parts list show the internal materials used in the SAR aqueous fluid systems are compatible according to the table specified. Analysis shall be performed on materials not listed in MSFC-SPEC-250, Table III. Verification success shall be when the analysis of the materials show the internal materials used in the SAR aqueous fluid systems do not create a dissimilar metal couple greater than 0.25 V with the ISS aqueous fluid system.

4.8.1.1.3 Connectors.

Connectors used in the SAR, external to the assembly level, consisting of MIL-C-38999, MIL-C-5015, MIL-C-81569, MIL-C-83733, or SSQ 21635 as specified in SSP 30243, Figure 4.1-8, shall be verified by inspection. The verification shall be considered successful when the inspection shows the connectors used in the SAR external to the assembly level, consist of MIL-C-38999, MIL-C-5015, MIL-C-81569, MIL-C-83733, or SSQ 21635 as specified in SSP 30423, Figure 4.1-8.

4.8.1.1.4 External cleanliness.

a. Verification that the SAR conforms prior to launch to VC-S cleanliness requirements as specified in SN-C-0005 shall be by inspection. An inspection of the cleanliness documentation required by precision cleaning shall be performed to show that each part, component, subsystem, and system of the end product meets the VC-S requirement. Verification shall be considered successful when the inspection shows that each part, component, subsystem, and system of the end product meets prior to launch the VC-S requirement.
b. Verification that the SAR external surfaces, with applicable PI hardware, meet the minimum acceptable cleanliness environment as measured by the US Lab shall be by inspection. The verification is considered successful when the inspection shows the SAR external surfaces, with applicable PI hardware, meet the minimum acceptable cleanliness environment as measured by the US Lab.

4.8.1.2 Toxic products and formulations.

The SAR toxic product and formulation requirements as specified in FCF-PLN-0036 shall be verified by inspection. The verification shall be considered successful when the inspection shows the SAR toxic product and formulation requirements as specified in FCF-PLN-0036 are met.

4.8.1.3 Volatile organic compounds.

The SAR volatile organic compound requirements as specified in FCF-PLN-0036 shall be verified by inspection. The verification shall be considered successful when the inspection shows the SAR volatile organic compound requirements as specified in FCF-PLN-0036 are met.

4.8.1.4 Hazardous materials.

The SAR hazardous material requirements as specified in FCF-PLN-0036 shall be verified by inspection. The verification shall be considered successful when the inspection shows the SAR hazardous material requirements as specified in FCF-PLN-0036 are met.

4.8.1.5 Protective coatings.

The SAR protective coating requirements as specified in FCF-PLN-0036 shall be verified by inspection. The verification is considered successful when the inspection shows the SAR protective coating requirements as specified in FCF-PLN-0036 are met.

4.8.2 Electromagnetic radiation.

4.8.2.1 Ionizing radiation.

Not applicable.

4.8.2.2 Nonionizing radiation.

Not applicable.

4.8.2.3 Operating environment.

Not applicable.

4.8.2.4 Generated environment.

Not applicable.

4.8.3 Nameplates and product marking.

4.8.3.1 Nameplates.

4.8.3.2 SAR identification and marking.

Labels on the SAR, all sub-rack elements (installed in the rack or separately), loose equipment, stowage trays, consumables, assemblies, crew accessible connectors and cables, switches, indicators, and controls shall be verified by inspection. The inspection shall be of the FCSD approval documentation. The verification shall be considered successful when the SAR, all sub-rack elements (installed in the rack or separately), loose equipment, stowage trays, consumables, assemblies, crew accessible connectors and cables, switches, indicators, and controls have been shown to have FCSD approved labels. The instructions for FCSD to follow in granting approval of labels are located in SSP 57000 Appendix C.

4.8.3.2.1 SAR component identification and marking.

All SAR parts legibly and permanently marked with a PIN shall be verified by inspection. The following exceptions shall apply to SAR component identification and marking:

a. Commercial-Off-the-Shelf (COTS) items marked with visible, permanent, and commercial identification.
b. Parts within a COTS assembly that are not subject to removal, replacement, or repair.
c. Parts within an assembly that are permanently installed and are not subject to removal, replacement, or repair.
d. Parts that cannot be physically marked or tagged due to lack of space or when marking would have a deleterious effect shall be temporarily tagged or packaged until the part is installed on the next higher assembly.

The verification shall be considered successful when the inspection shows all SAR parts legibly and permanently marked with a PIN, excluding the exceptions listed above.

4.8.3.2.2 SAR lighting design.

a. Verification of the specularity of the total work surface reflection shall be by test or inspection. The test shall be considered successful when the specularity of the total work surface reflection does not exceed 20%. The inspection shall be considered successful if the work space surface uses paint(s) selected from Table XVI. If other work surface coatings are used, the test shall be considered successful if the measured specularity of the work surface does not exceed 20%.
b. The task illumination level identified in Table XVII shall be verified by test. The test shall be considered successful when illumination levels measured at the task site(s) meet those identified in Table XVII.
c. The use of the PUL for medium SAR operational tasks shall be verified by analysis or test. The analysis or test shall show the PUL placed in a configuration that provides the required level of illumination at the task site. The analysis or test shall be considered successful when it shows that the SAR is designed to use the PUL for all medium SAR operational tasks.

TABLE XVI. Surface interior colors and paints

HARDWARE DESCRIPTION	COLOR	FINISH	PAINT SPECIFICATION PER FED–STD–595
Equipment Rack Utility Panel Recess	White	Semigloss	27925
Equipment Rack Utility Panel Text Characters	Black	Lusterless	37038
International Std. Payload Rack Primary Structure	Off-White	Semigloss	27722
ISPR Utility Panel Recess	White	Semigloss	27925
ISPR Utility Panel Recess Text Characters	Black	Lusterless	37038
Functional Unit Rack (Primary Structure)	Off-White	Semigloss	27722
Functional Unit Utility Panel Recess (as applicable)	White	Semigloss	27925
Functional Unit Utility Panel Recess Text Characters	Black	Lusterless	37038
Rack Front Aisle Extensions	Off-White	Semigloss	27722
Ceiling Rack Face Plates	Off-White	Semigloss	27722
Port Rack Face Plates	Off-White	Semigloss	27722
Starboard Rack Face Plates	Off-White	Semigloss	27722
Floor Rack Face Plates	Off-White	Semigloss	27722
Ceiling Rack Utility Panel Closeouts	Off-White	Semigloss	27722
Port Rack Utility Panel Closeouts	Off-White	Semigloss	27722
Starboard Rack Utility Panel Closeouts	Off-White	Semigloss	27722
Floor Rack Utility Panel Closeouts	Off-White	Semigloss	27722
Stowage Trays	Off-White	Semigloss	27722
Stowage Tray Handle Straps (any location)	Blue material	Semigloss	25102 or equiv.
Common Seat Track Interface	Clear (Anodized)	Semigloss	none
Glovebox (Aluminum or Plastic)	Medium Gray	Gloss	16329 or 16373
Glovebox (Aluminum)	White	Gloss	17925
Glovebox (Aluminum or Plastic)	Off-White	Gloss	17722
Glovebox (Aluminum)	Tan	Gloss	10475
EXPRESS Program Rack Utility Panels	Off–White	Gloss	17875

TABLE XVII. SAR required illumination levels

Type of Task	Required Lux (Foot-Candles)*
Medium payload operations (not performed in the aisle) (e.g., payload change-out and maintenance)	325 (30)
Fine payload operations (e.g., instrument repair)	1075 (100)
Medium glovebox operations (e.g., general operations, experiment set-up)	975 (90)
Fine glovebox operations (e.g., detailed operations, protein crystal growth, surgery/dissection, spot illumination)	1450 (135)

* As measured at the task site

d. All text on surfaces intended to be read by the on-orbit crew being black lusterless, 37038 as specified in FED-STD-595, on off-white, semi-gloss, 27722 background as specified in FED-STD-595 shall be verified by inspection. The verification shall be considered successful when the inspection shows all text on surfaces intended to be read by the on-orbit crew is black lusterless, 37038 as specified in FED-STD-595, on off-white, semi-gloss, 27722 background as specified in FED-STD-595.

e. Verification of all aluminum surfaces susceptible to wear being clear or black hard coat anodized or equivalent shall be verified by inspection. The verification shall be considered successful when the inspection shows all aluminum surfaces susceptible to wear are clear or black hard coat anodized or equivalent.
f. SAR components exempt from the lighting design requirement if the surfaces are color coded to meet other requirements as specified herein, such as interior component surfaces, COTS components, fluid system tubing, and surfaces required by science or safety to exhibit specific characteristics shall be verified by inspection. The verification shall be considered successful when the inspection shows all exempted components meet the exemption requirements specified herein.

4.8.3.2.3 Touch temperature warning labels.

Warning labels provided at the surface site of any SAR component that exceeds a temperature of 49°C (120°F), including surfaces not normally exposed to the cabin, in accordance with the NASA IVA Touch Temperature Safety interpretation letter JSC, MA2-95-048 shall be verified by analysis and inspection. The analysis verification shall be considered successful when the analysis shows the locations where warning labels are required. The inspection verification shall be considered successful when the inspection shows the warning labels provided at the identified surface site.

4.8.3.2.4 Connector coding and labeling.

a. The coding of both halves of SAR mating connectors shall be verified by inspection. Verification shall be considered successful when an inspection shows that both halves of mating connectors display a code or identifier which is unique to that connection.
b. Connector coding and labeling shall be verified by inspection. Verification shall be considered successful when an inspection shows that labels or codes on connectors are visible when connected or disconnected.
c. Pin identification shall be verified by inspection. Verification shall be considered successful when an inspection shows that each pin is uniquely identifiable in each plug and each electrical receptacle with at least every 10th pin labeled.

4.8.3.3 Portable fire extinguisher (PFE) and fire detection indicator labeling.

a. Verification that the PFE access port is labeled with a SDD32100397-002 “Fire Hole Decal” shall be by inspection. Verification shall be considered successful when the inspection shows a SDD32100397-002 “Fire Hole Decal” was placed over the PFE access port.
b. Verification that the SAR Fire Detection Indicator LED is labeled with “SMOKE INDICATION” shall be by inspection. Verification shall be considered successful when the inspection shows the label “SMOKE INDICATION” has been placed above the Fire Detection Indicator LED using lettering per MSFC-STD-275 with 3.96-mm (0.156-in.) letters, style Futura Demibold, and color 37038 (Lusterless Black) per FED-STD-595. The SAR using the ISS provided LED on the Rack Maintenance Switch Assembly (RMSA) with

the engraved “SMOKE INDICATION” label shall be considered in compliance with this requirement.

4.8.3.4 Electrostatic discharge sensitive parts labeling.

Verification that all parts sensitive to damage from ESD are properly labeled shall be by inspection based on physical/visual indication of the SAR. The inspection shall be considered successful when physical/visual indications show the labeling of EPCE susceptible to ESD up to 15, 000 V are in accordance with MIL-STD-1686.

4.8.4 Workmanship.

Verification that the SAR, with applicable PI hardware, conforms to the workmanship standards in accordance with NHB 5300.4(1B) shall be by inspection. The verification shall be considered successful when the inspection shows the SAR, with applicable PI hardware, conforms to the workmanship standards in accordance with NHB 5300.4(1B).

4.8.5 Interchangeability.

Verification that all ORU’s with the same part number are functionally and dimensionally interchangeable shall be by demonstration. The verification shall be considered successful when the demonstration shows all ORU’s with the same part number are functionally and dimensionally interchangeable.

4.8.5.1 On-orbit interchangeability.

Verification that the assemblies and components listed below are interchangeable on-orbit shall be by demonstration. The verification shall be considered successful when the demonstration shows the capability that the assemblies and components listed below are interchangeable on-orbit.

a. IOP
b. EPCU
c. IOP Disk Drives
d. All Temperature Sensors
e. All Pressure Sensors
f. All Solenoid Valve Coils
g. ATCS Air Filters

4.8.6 Safety.

Verification that the SAR, with applicable hardware and software, meets the applicable requirements as specified in NSTS 1700.7, ISS Addendum shall by analysis, inspection, and test. Verification shall be considered successful when hazard reports and safety data presented to the PSRP during the phased safety reviews are approved.

4.8.6.1 Fire prevention.

Verification that the SAR meets the fire prevention requirements specified in NSTS 1700.7, ISS Addendum, paragraph 220.10 a. shall by analysis and inspection. Verification shall be considered successful when hazard reports and safety data presented to the PSRP during the phased safety reviews are approved.

4.8.6.1.1 Smoke detector.

a. Verification that the SAR uses a smoke detector that meets the requirements specified in D683-10007 and SSP 30262:013 shall be by inspection. Verification shall be considered successful when the inspection shows the end item spec and Interface Control Document of the smoke detector used meets the requirements specified in D683-10007 and SSP 30262:013 respectively. If the SAR uses the ISS provided smoke detector, the SAR shall be considered in compliance with this requirement.
b. Verification that the SAR provides a smoke detector interface at the J43 connection shall be by inspection and demonstration. The inspection shall consist of reviewing schematics/drawings to verify they show wiring to the J43 connector. The verification shall be considered successful when the inspection shows wiring from the smoke detector to the J43 connector. The demonstration shall be conducted to show the connector mates with the ISS equivalent connector. The verification shall be considered successful when the demonstration shows the connector mates with the ISS equivalent connector.

4.8.6.1.1.1 Maintenance switch, smoke detector, smoke indicator, and SAR fan interfaces.

Verification of the SAR maintenance switch interface shall be by inspection and test. Verification shall be by inspection of the SAR maintenance switch interface to the SAR hardware ICD against and SSP 57001. Verification shall be to test the SAR with the PRCU, for correct operation of the SAR maintenance switch.

4.8.6.1.1.2 Smoke detector analog interface characteristics.

Verification of the analog interface characteristics shall be by inspection. Verification shall be by inspection of the analog interface characteristics to the SAR hardware ICD against and SSP 57001.

4.8.6.1.1.3 Discrete command built-in-test interface characteristics.

Verification of the discrete command BIT interface characteristics shall be by inspection. Verification shall be by inspection of the discrete command BIT interface characteristics to the SAR hardware ICD against and SSP 57001.

4.8.6.1.1.4 Smoke indicator electrical interfaces.

Verification of the smoke indicator electrical interface shall be by inspection and test. Verification shall be by inspection of the discrete command BIT interface characteristics to the

SAR hardware ICD against and SSP 57001. Verification shall be to test the SAR with the PRCU, for function of the smoke indicator on P43. No test on the luminance of the indicator is required.

4.8.6.1.1.5 Fan ventilation status electrical interfaces.

Verification of the discrete command BIT interface characteristics shall be by inspection. Verification shall be by inspection of the discrete command BIT interface characteristics to the SAR hardware ICD against and SSP 57001.

4.8.6.1.1.6 Rack maintenance switch (rack power switch)/fire detection support interface connector.

Verification of the SAR Switch/Fire Detection Support Interface (maintenance) Connector shall be by inspection. Verification shall be by inspection of the SAR Maintenance Connector to mate with a Test Connector SSQ 21635, NATC07T13N35SA.

a. NVR. Physical mating verification requirements are specified in paragraph 4.2.7.
b. Verification of P43 appropriate pin assignment shall be by inspection. The inspection shall be an inspection of payload drawings to verify that the P43 pinout matches the corresponding J43 pinout. The verification shall be considered successful when the inspection shows that the P43 connector pinout is appropriate.
c. Verification of the P43 connector with the requirements of SSQ 21635 shall be by inspection. The inspection shall consist of an inspection of the drawings to identify that the SSQ 21635 requirement is identified on the drawing for the P43 connector.

4.8.6.1.2 Fire detection indicator.

a. Verification that the SAR using a smoke detector providing a red Fire Detection Indicator LED in an easily visible location on the front of the rack shall be by test and inspection. The test shall show the LED meets or exceeds the operational characteristics of the ISS provided LED when provided the interface characteristics defined in SSP 57000, paragraph 3.3.10. Test verification shall be considered successful when the test shows the indicator LED meets or exceeds the operational characteristics of the ISS provided LED when provided the interface characteristics defined in SSP 57000, paragraph 3.3.10. The SAR using the ISS provided Fire Detection Indicator LED shall be considered in compliance with this requirement. The inspection shall show the LED is positioned in an obvious, easily viewed location on the aisle side of the SAR. Inspection verification shall be considered successful when the inspection shows the LED is positioned in an obvious, easily viewed location on the aisle side of the SAR.
b. Verification that the SAR provides a fire detection indicator interface at the J43 connection shall be by inspection. The inspection shall consist of reviewing schematics/drawings to verify they show wiring to the J43 connector. The verification shall be considered successful when the inspection shows wiring from the fire detection indicator to the J43 connector.

4.8.6.1.3 Forced air circulation indication.

Verification that the SAR provides a signal or data indicating whether or not air flow is being provided to the smoke detector when the smoke detector is in use shall be by test. Verification shall be considered successful when the test shows signal strength meets the interface characteristics in FCF-SPC-0004, paragraphs 3.3.6.1.1.1 through 3.3.6.1.1.6 when airflow of 3-30.5 m/s (10–100 ft/s) is provided at the smoke detector.

4.8.6.1.4 Fire parameter monitoring in the SAR.

a. Verification that the SAR provides manual and automatic capability to terminate forced air circulation (if present) and power to the SAR shall be by test. A test with the PRCU or equivalent shall be conducted to determine whether or not forced air circulation and electrical power can be manually or automatically terminated in the SAR when an “out of bounds” condition is indicated by the parameter monitoring sensors. Verification shall be considered successful when the test shows forced air circulation and electrical power can be terminated manually or automatically when an “out of bounds” condition is indicated by the parameter monitoring sensors.
b. Verification that the SAR responds to an “out of bounds” condition by sending data to indicate the occurrence and location of the “out of bounds” condition to the payload MDM in the format specified in FCF-SPC-0004, paragraph 3.4.1.1.5.4 shall be by test. A test with the PRCU or equivalent shall determine whether or not the SAR health and status data is formatted to indicate the occurrence and location of an “out of bounds” condition when one is indicated by parameter monitoring sensors. Verification shall be considered successful when the test shows data is sent in the format specified in FCF-SPC-0004, paragraph 3.4.1.1.5.4 to indicate the occurrence and location of an “out of bounds” condition when one is indicated by the parameter monitoring sensors.

4.8.6.1.5 Fire suppression access port accessibility.

a. Verification that SAR provides a PFE access port for each rack volume containing a potential fire source shall be by inspection and analysis. An analysis of the SAR volume design shall be conducted to determine whether or not the SAR volume contains a potential fire source. If there is a potential fire source present, an inspection shall be conducted to determine whether or not an access port with a diameter between 12.7 mm (0.5 in.) and 25.4 mm (1.0 in.) is provided, if the panel thickness is less than or equal to 3.175 mm (0.125 in.). Verification shall be considered successful when the inspection of the drawings or hardware show an access port with a diameter between 12.7 mm (0.5 in.) and 25.4 mm (1.0 in.) is provided for each volume containing a potential fire source if the panel thickness is less than 3.175 mm (0.125 in.).
b. Verification that the design of the SAR permits the PFE nozzle to interface with the access port shall be by demonstration. Verification shall be considered successful when the demonstration shows the design of the SAR, including protrusions, allows the PFE nozzle to interface with the access port over the face of the SAR, without relying on areas adjacent to the SAR.

4.8.6.1.6 Fire suppressant distribution.

Verification that the internal layout of the SAR will allow ISS PFE fire suppressant to be distributed to the entire volume that PFE access port serves, lowering the oxygen concentration to or below 10.5% by volume at any point within the enclosure within one minute shall be by analysis or test. Referring to rack qualification tests, which show the ISS PFE will reduce the rack volume oxygen concentration to or below 10.5% by volume within one minute, an analysis shall be performed on the SAR to determine whether or not the internal layout of the integrated rack prevents suppressant from flowing to any volume internal to the volume that PFE access port serves. When verified by test, the test shall be performed to determine whether or not the ISS PFE fire suppressant, as specified in Figure 30, is distributed to the entire volume that PFE access port serves, lowering the oxygen concentration to or below 10.5% by volume at any point within the enclosure within one minute. Verification shall be considered successful when the analysis or test shows the internal layout of the SAR will allow ISS PFE fire suppressant to be distributed to the entire volume a PFE access port serves, lowering the oxygen concentration to or below 10.5% by volume at any point within the enclosure within one minute.

4.8.6.2 SAR front surface temperature.

Verification that the average SAR front surface temperature and maximum temperature limits will not be exceeded during all modes of operation shall be by analysis or test. The verification shall be considered successful when the analysis or test results show the SAR surface average and maximum limit temperatures are less than those specified.

4.8.6.3 Electrical hazards.

For the SAR, verification of hazard controls shall be by analysis and/or test. The analysis and/or test shall: (1) define the maximum voltage and current profiles to which a crew member might be exposed by the worst case combination of credible failures, events, and/or environments the equipment might experience, and (2) show that the crew is protected by the controls incorporated in the equipment. Verification shall be considered successful when it shows that the appropriate requirements from the following list are satisfied:

a. NVR.
b. The exposure condition exceeds the threshold for shock, but is below the threshold of the let-go current profile (critical hazard) as defined in Table XVIII, and two independent controls (e.g., a safety (green) wire, bonding, insulation, leakage current levels below maximum requirements) are provided, and the design of the controls is such that no single failure, event, or environment can eliminate more than one control.

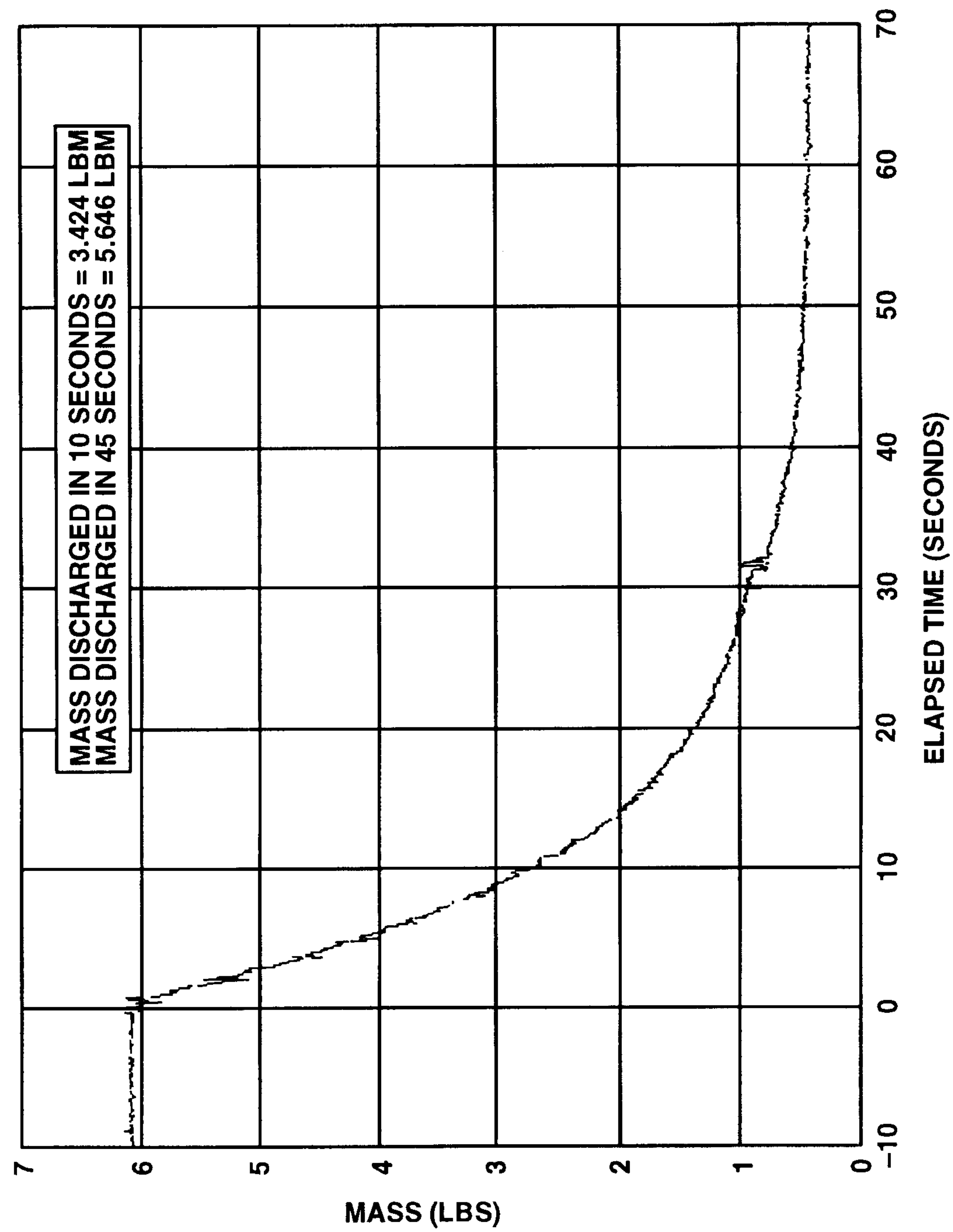


FIGURE 30. Manual fire suppression system performance characteristics at the rack interface

c. The exposure condition exceeds both the threshold for shock and the threshold of the let-go current profile (catastrophic hazardous events) as defined in Table XVIII, and three independent controls are provided, and the design of the controls is such that no combination of two failures, events or environments can eliminate more than two controls.

d. If two dependent controls are provided, the physiological effect that a crew member experiences as a result of the combinations of the highest internal voltage applied to or generated within the equipment and the frequency and wave form associated with a worst case credible failure is below the threshold of the let-go current profile as defined in Table XVIII.
e. If the analysis fails to clearly define the exposure condition that a crew member might experience, three independent hazard controls are provided and the design of the controls is such that no combination of two failures, events, or environments can eliminate more than two controls.

4.8.6.4 Connector mating.

The design of electrical connectors to preclude inadvertent reversal of connections shall be verified by analysis, inspection, and demonstration. The verification shall be considered successful only when all of the SAR electrical connectors, and wire harnesses requiring crew access to mate/demate during on-orbit operations are demonstrated to meet the requirements.

4.8.6.5 Mating/demating of powered connectors.

Verification that the SAR connected to Interface B meets the loss of power safety requirements specified in NSTS 1700.7, ISS Addendum shall be by analysis. Verification shall be considered successful when hazard reports and safety data presented to the PSRP during the phased safety reviews are approved.

Frequency (Hertz)	Maximum Total Peak Current (AC + DC components combined) (milliamperes)
DC	40
15	8.5
2000	8.5
3000	13.5
4000	15.0
5000	16.5
6000	17.9
7000	19.4
8000	20.9
9000	22.5
10000	24.3
50000	24.3
(Based on 99.5 Percentile Rank of Adults)	

TABLE XVIII. Let-go current profile threshold versus frequency

4.8.6.6 Safety-critical circuit redundancy.

Verification that the SAR connected to Interface B meets the loss of power safety requirements specified in NSTS 1700.7, ISS Addendum shall be performed by analysis. Verification shall be considered successful when hazard reports and safety data presented to the PSRP during the phased safety reviews are approved.

4.8.6.7 Rack maintenance switch (rack power switch).

Rack maintenance switch shall be verified by inspection and demonstration. The inspection shall ensure the SAR is equipped with a rack maintenance switch on the front of the SAR. The demonstration shall be performed to ensure the data signals from the rack maintenance switch indicate the designed voltage and current levels expected for both the on and off positions. The verification shall be considered successful when the inspection shows the SAR is equipped with a rack maintenance switch on the front of the SAR and demonstration that data signals from the rack maintenance switch indicates the designed voltage and current levels expected for both the on and off positions.

4.8.6.8 Power switches/controls.

The power switches/controls requirements shall be verified by analysis for power interfaces with open circuit voltage exceeding 30 Vrms or dc nominal (32 Vrms or dc maximum).

a. Switches/controls requirement shall be verified by analysis. An analysis shall be performed to ensure the switches/controls performing on/off functions for all power interfaces open (dead-face) all supply circuit conductors, except the power return and equipment grounding conductor, while in the power-off position. Verification shall be considered successful when analysis of electrical circuit schematics shows the switches/controls performing on/off power functions for all power interfaces open (dead-face) all supply conductors except the power return and equipment grounding conductor, while in the power-off position.
b. Power-off markings and/or indications requirement shall be verified by analysis. The analysis shall ensure power-off markings and/or indications exist when all electrical connections with the power supply circuit are disconnected. The verification shall be considered successful when analysis shows power switches/controls power-off markings and/or indication(s) exist when all electrical connections with the power supply circuit are disconnected.
c. The standby, charging, and descriptive nomenclature requirement shall be verified by analysis. The analysis shall ensure the existence of descriptive nomenclature such as standby, charging, or that necessary to indicate the power supply circuit is not completely disconnected for this power condition. The verification shall be considered successful when analysis shows descriptive nomenclature exists to indicate the power supply circuit is not completely disconnected.

4.8.6.9 Ground fault circuit interrupters (GFCI)/portable equipment dc sourcing voltage.

Ground Fault Circuit Interrupters/portable equipment dc sourcing voltage requirement shall be verified by demonstration, test, and analysis.

a. The analysis of electrical wiring schematics shall ensure a GFCI is in the non-portable utility outlet and is in the power path to portable equipment receiving voltages, exceeding 30 Vrms nominal voltage, or dc nominal voltage (32 Vrms or dc maximum) from a non-portable utility outlet. The verification shall be considered successful when the analysis shows a GFCI is in the non-portable utility outlet and is in the power path between the non-portable utility outlet power source, supplying output voltages exceeding 30 Vrms or dc nominal voltages (32 Vrms or dc maximum), and the load receiving power from the non-portable utility outlet.
b. The test shall ensure the dc trip detection is independent of the portable equipment's safety (green) wire. The verification shall be considered successful when the test shows the dc trip detection does not depend on the current sensing of the portable equipment's safety (green) wire.
c. The test shall ensure the ac trip detection is dependent on the portable equipment's safety (green) wire when the safety (green) wire is present. The verification shall be considered successful when the test shows the ac trip detection depends on the current sensing of the portable equipment's safety (green) wire when the safety (green) wire is present. If an analysis including all the loads which may be connected to the utility outlet shows that ac fault currents do not exist under any failure conditions, this test is not required.
d. The analysis shall ensure the GFCI protection is included within the portable equipment and is in the credible fault path or return path, defined and documented in the Hazard Analysis, for equipment with internal voltages greater than 30 Vrms or dc nominal (32 Vrms or dc maximum). A credible fault/return path within the portable equipment is a fault/return path to a crew member not protected by the GFCI within the utility outlet supplying power to the portable equipment. The test shall ensure that GFCI trips without exceeding the currents specified in Table XVIII. The verification shall be considered successful when the analysis shows the GFCI protection is included within the portable equipment and is in the credible fault path or return path to a crew member for portable equipment with nominal voltage above 30 Vrms or dc (32 Vrms or dc maximum) and the test shows GFCI trips before exceeding the current levels specified in Table XVIII.
e. The test shall ensure non-portable utility outlets, supplying power to portable equipment, include GFCI that trips without exceeding the currents specified in Table XVIII. The verification shall be considered successful when the test shows GFCI, within non-portable utility outlets, trips before exceeding the current levels specified in Table XVIII. If an analysis including all the loads which may be connected to the utility outlet shows that ac fault currents do not exist under any failure conditions, this test for ac current is not required.
f. The test shall ensure the GFCI removes power from the output power leads within 25 ms upon encountering the fault current. The verification shall be considered successful when the test shows GFCI removes power from the output power leads within 25 ms upon encountering the fault current.
g. The analysis shall ensure the GFCI provides an on-orbit method for testing the trip current detection threshold at dc and at a frequency within the maximum human sensitivity range of 15 to 70 Hz. The method for the GFCI on-orbit checkout shall be verified by demonstration. The verification shall be considered successful when the analysis shows GFCI provides an on-orbit method and procedure for testing the trip current detection threshold at dc and at a frequency within 15 to 70 Hz, and the demonstration shows that the on-orbit checkout method will trip the GFCI circuit and the GFCI circuit can be manually reset.

4.8.6.10 Portable equipment/power cords.

a. Analysis of schematics shall ensure non-battery powered portable equipment, incorporates a three-wire power cord containing a supply (+) lead, a return (–) lead, and a safety (green) wire. Verification shall be considered successful when the analysis shows the portable equipment/power cords contains a supply (+) lead, a return (–) lead, and a safety (green) wire with one end connected to the portable equipment chassis (and all exposed conductive surfaces) and the other end connected to structure at the utility outlet or though the GFCI interface if GFCI is used. Use of double insulation or its equivalent without the safety (green) wire, when used as an alternative, shall be documented in the SAR ICD as an exception.
b. The analysis shall ensure the fault currents though the credible fault path or return path to the crew member resulting from a single failure at the primary (input) side of the power converter within non-battery powered portable equipment, i.e., portable equipment receiving power from the utility outlet provided by ISS or payload, do not exceed the total peak currents specified in Table XVIII for fault current frequencies of 15 Hz and above. Verification shall be considered successful when the analysis shows fault current resulting from a single failure does not exceed the total peak currents specified in the profile shown in Table XVIII for fault current frequencies of 15 Hz and above. The verification is not required for portable equipment with internal voltages below 30 Vrms or dc nominal (32 Vrms or dc maximum).

4.8.6.11 Overload protection.

4.8.6.11.1 Device accessibility.

Verification that an overload protective device will not be accessible without opening a door or cover (except operating handles or buttons of a circuit breaker, the cap of an extractor-type fuse holder, and similar parts may project outside the enclosure) shall be by hardware inspection. Verification shall be considered successful when hardware inspection shows a door or cover must be opened to access the overload protective device.

4.8.6.11.2 Extractor-type fuse holder.

Verification that the arrangement of the extractor-type fuse holder operates such that the fuse is extracted when the cap is removed shall be by demonstration. Verification shall be considered successful when demonstrations show the fuse is extracted when the removable cap assembly is removed.

4.8.6.11.3 Overload protection location.

Verification that overload protection (fuses and circuit breakers) intended to be manually replaced or physically reset on-orbit are located where they can be seen and replaced or reset without removing other components shall be by hardware inspection. Verification shall be considered successful when hardware inspection results show that overload protection devices are directly visible and accessible without removal of other components.

4.8.6.11.4 Overload protection identification.

Verification that each overload protector (fuse or circuit breaker), intended to be manually replaced or physically reset on orbit, shall be readily identified or keyed (mechanically or color coded) for its rated value shall be by hardware inspection. Verification shall be considered successful when hardware inspection results show the rated identification for each overload protector is in place.

4.8.6.11.5 Automatic restart protection.

Verification shall be by demonstration. The demonstration shall first induce an “Overload Initiated Shutdown” as defined in SSP 57000, paragraph 3.2.2.6.1.1 and then observe system response to assure that automatic restart does not occur unless the protection switch/control is explicitly operated to enable restarting. The verification of automatic restart protection shall be considered successful when it shows that automatic restart cannot occur following an overload-initiated shutdown without explicit operation of the protection switch/control to enable restarting.

4.8.6.12 Sharp edges and corners protection.

Verification that the hardware meets the sharp edges and corners requirements specified in NSTS 1700.7, ISS Addendum, paragraph 222.1 shall be by inspection of the drawings and assembled SAR hardware. Verification shall be considered successful when the hazard reports and safety data presented to the PSRP during the phased safety reviews are approved.

4.8.6.13 Holes.

An analysis shall be performed using data from drawings, integration documentation, and operational procedures to identify holes in IVA crew member translation paths and maintenance work sites. A drawing inspection shall show that the proper hole sizes have been used or proper guards are in place. Verification shall be considered successful when analysis and inspection shows that all holes are of the proper size, covered, or guarded.

4.8.6.14 Latches.

Verification shall be by inspection. The verification shall be considered successful when the inspection shows that all latches and similar devices have been properly covered or guarded and designed to prevent entrapment of crew member appendages.

4.8.6.15 Screw and bolts.

Verification shall be by analysis and inspection. An analysis shall be performed using data from drawings, integration documentation, and operational procedures to identify screws and bolts which exceed the length specified in the requirements and the required use of guards or covers due to location in crew member translation paths and maintenance work sites. A drawing inspection shall show that the required cover installation has been accomplished or proper guards are in place. Verification shall be considered successful when analysis and inspection shows that screws and bolts which exceed the specified length have been properly covered or guarded.

4.8.6.16 Securing pins.

An analysis of the SAR hardware and flight drawings shall be performed to verify requirement. The verification shall be considered successful when the analysis shows the requirement has been met.

4.8.6.17 Levers, cranks, hooks, and controls.

Verification shall be by analysis and inspection. The verification shall be considered successful when the inspection and analysis shows that all levers, cranks, hooks, and controls have been properly covered or guarded and cannot pinch, snag, or cut the crew members or their clothing.

4.8.6.18 Burrs.

Verification shall be by inspection. The verification shall be considered successful when the inspection shows that all edges have been properly deburred.

4.8.6.19 Locking wires.

a. An analysis of payload hardware and flight drawings shall be performed to verify requirement. The verification shall be considered successful when the analysis shows the requirement has been met.
b. An inspection of payload hardware or flight drawings shall be performed to verify compliance with the requirement. The verification shall be considered successful when the inspection shows the requirement has been met.

4.8.6.20 Audio devices (displays).

a. Verification that the audio devices and circuits protect against false alarm shall be by analysis. The verification shall be considered complete when analysis shows that protective measures have been taken.
b. Verification of circuit test devices or other means of operability testing shall be by demonstration. The requirement will be met when demonstration shows that the circuit test device correctly indicates when the audio device is working and when it is not working.
c. Verification of the manual disable device shall be by an analysis that determines whether any failure modes can result in sustained activation of the audio device. If no such failure mode exists, then further verification is not required. However, if analysis shows that there are failure modes that can result in sustained activation of the audio device, then demonstration of the manual disable mode shall be required. In that case, the requirement shall be considered successful when demonstration shows that the audio device can be manually turned off.

4.8.6.21 Egress.

Verification of this requirement shall be verified by analysis to show that the crew is not impeded by the SAR in the event of an IVA. Verification shall be considered successful when hazard reports and safety data presented to the PSRP during the phased safety reviews are approved.

4.8.6.22 Failure tolerance.

SAR single fault tolerance for the operation of a computer to identify failures to allow for active troubleshooting shall be verified by analysis. Verification shall be considered successful when the analysis shows the SAR single fault tolerance for the operation of a computer identifies failures to allow for active troubleshooting.

4.8.6.23 Failure propagation.

a. Verification of the SAR design that a failure within an assembly will not induce any failure external to the failed assembly shall be by analysis. Verification shall be considered successful when the analysis shows the SAR is designed such that a failure within an assembly will not induce any failure external to the failed assembly.
b. Verification of the SAR design that a failure within the SAR will not induce a failure to any system or component external to the SAR shall be by analysis. Verification shall be considered successful when the analysis shows the SAR is designed such that a failure within the SAR will not induce a failure to any system or component external to the SAR.

4.8.6.24 Separation of redundant paths.

Verification that alternate or redundant electrical functional paths are provided for all paths where electrical or electronic harnesses cannot be replaced on orbit shall be by analysis. Verification shall be considered successful when the analysis shows alternate or redundant electrical functional paths are provided for all paths where electrical or electronic harnesses cannot be replaced on orbit.

4.8.6.25 Incorrect equipment installation.

Verification that the SAR assemblies and components that are replaceable on orbit are designed to contain physical provisions to preclude incorrect installation which may result in damage to equipment or hazardous conditions shall be by analysis. Verification shall be considered successful when the analysis shows the SAR assemblies and components that are replaceable on orbit are designed to contain physical provisions to preclude incorrect installation which may result in damage to equipment or hazardous conditions.

4.8.6.26 Chemical releases.

Verification of this requirement shall be by analysis. Verification shall be considered successful when hazard reports and safety data presented to the PSRP during the phased safety reviews are approved.

4.8.6.27 Single event effect (SEE) ionizing radiation.

Verification that the SAR and assemblies are designed to not produce an unsafe condition or one that could cause damage to equipment external to the SAR as a result of exposure to SEE ionizing radiation shall be by analysis. An analysis of the SAR and assemblies shall be performed using the operational lifetime and parts characterization data to assure that the design meets the requirement when exposed to SEE ionizing radiation. The verification shall be considered successful when the analysis shows that the SAR and assemblies will not produce an unsafe condition or one that could cause damage to equipment external to the SAR when exposed to the specified environment.

4.8.6.28 Potential hazardous conditions.

a. The SAR capability to determine if any out-of-tolerance conditions will lead to a hazardous condition and take steps necessary to prevent the hazardous condition shall be verified by test. The verification shall be considered successful when the test shows the SAR capability to determine if any out-of-tolerance conditions will lead to a hazardous condition and take steps necessary to prevent the hazardous condition.
b. Any autonomous reconfigurations performed to prevent a hazardous condition from occurring capability of being overridden shall be verified by test. The verification shall be considered successful when the test shows that any autonomous reconfigurations performed to prevent a hazardous condition from occurring capability of being overridden.

4.8.6.29 Withstand external environment.

The SAR capability to withstand changes in its external environment to prevent hazardous conditions within the SAR from occurring internal or external to the SAR shall be verified by inspection. The verification shall be considered successful when the SAR successfully completes all the requirements of the PSRP.

4.8.7 Human performance/human engineering.

4.8.7.1 Strength requirements.

a. Normal Operations:
    1. Grip strength shall be verified by analysis or demonstration. The verification shall be considered successful when the analysis or demonstration shows that the grip strength required to remove, replace, and operate the SAR and its assemblies are as specified.
    2. Linear forces shall be verified by analysis or demonstration. The verification shall be considered successful when the analysis or demonstration shows that the linear forces required to remove, replace, and operate the SAR and its assemblies are as specified.
    3. Torsional forces shall be verified by analysis or demonstration. The verification shall be considered successful when the analysis or demonstration shows that the torsional forces required to remove, replace, and operate the SAR and its assemblies are as specified.
b. Maintenance Operations:
    Forces shall be verified by analysis or demonstration. The verification shall be considered successful when the analysis or demonstration shows that the strength values required to perform maintenance operations on the SAR and its assemblies are as specified.

4.8.7.2 Adequate crew clearance.

The SAR clearance shall be verified by analysis or demonstration. The analysis shall be based on an evaluation of the drawing(s) with the clearance requirements to perform the tasks using the tools and equipment utilized in SAR installation, operations, and maintenance. The demonstration shall be performed on the flight hardware or hardware which replicates the flight hardware configuration with the tools and equipment utilized in SAR installation, operations, and maintenance. The verification shall be considered successful when the analysis or demonstration shows that the clearance accommodates crew performance of tasks, including tool utilization, and is sufficient to install/de-install, replace, operate, and maintain the SAR, its assemblies, and components.

4.8.7.3 Accessibility.

a. SAR hardware accessibility shall be verified by analysis or demonstration. The verification shall be considered successful when the analysis or demonstration shows that the specified accessibility is sufficient to remove, replace, operate, and maintain the SAR equipment.
b. IVA clearances shall be verified by analysis or demonstration. The verification shall be considered successful when the analysis or demonstration shows the specified IVA clearances.

4.8.7.4 Full size range accommodation.

Analyses of end item drawings that contain on-orbit crew interfaces shall be performed to verify that SAR hardware accommodates the 5th percentile Japanese female to the 95th percentile American male size measurements, estimated for the year 2000, as specified in SSP 50005, Anthropometric and Biomechanics Related Design data. Drawings of work stations and hardware having crew nominal operations and planned maintenance shall be analyzed to verify that they are sized to meet the functional reach limits for the 5th percentile Japanese female. Drawings of work stations and hardware having crew nominal operations and planned maintenance shall be analyzed to verify that they are sized to not confine the body envelope of the 95th percentile American male.

4.8.7.5 Housekeeping closures and covers.

Design of closures or covers shall be verified by inspection of the integrated rack drawings. Verification shall be considered successful when inspection of the flight hardware confirms compliance with the requirement.

4.8.7.6 Built-in housekeeping control.

a. Design of built-in controls shall be verified by inspection of the integrated rack drawings. Verification shall be considered successful when inspection of the flight hardware confirms compliance with the requirement.
b. Crew access to capture elements shall be verified by analysis or demonstration. The verification shall be considered successful when the analysis or demonstration shows that the crew can access the flight hardware capture elements for cleaning or replacement without dispersion of trapped material.

4.8.7.7 One-handed operation.

Verify by demonstration that cleaning equipment and supplies can be operated using only one hand.

4.8.7.8 Acoustic requirements.

4.8.7.8.1 Continuous noise limits.

Verification of continuous noise sources for the SAR shall be verified using a test-correlated analytical model, or some other method approved and documented in FCF-PLN-0023. The analytical model shall include system noise sources and anticipated sub-rack payload complement noise sources. The test-correlated model process is shown in Figure 31. The verification shall be considered successful when the results from the test-correlated analytical model predict the loudest location 0.6 m from the SAR surface exposed to the crew habitable volume, in each of the eight octave bands defined in Table XIX, to be at or below the levels specified in Table XIX for additions, deletions, or configuration changes to any SAR equipment within the SAR.

4.8.7.8.2 Intermittent noise limits.

Verification of intermittent noise sources for the SAR shall be performed using a test-correlated analytical model, or some other method approved and documented in FCF-PLN-0023. A test-correlated model as depicted in Figure 31, or other approved verification method for the integrated rack for maximum rack noise duration as defined in Table XX, shall be used to perform SAR analysis. The analysis shall exercise the test-correlated model for every intermittent noise occurrence and quantify the noise characteristics in terms of:

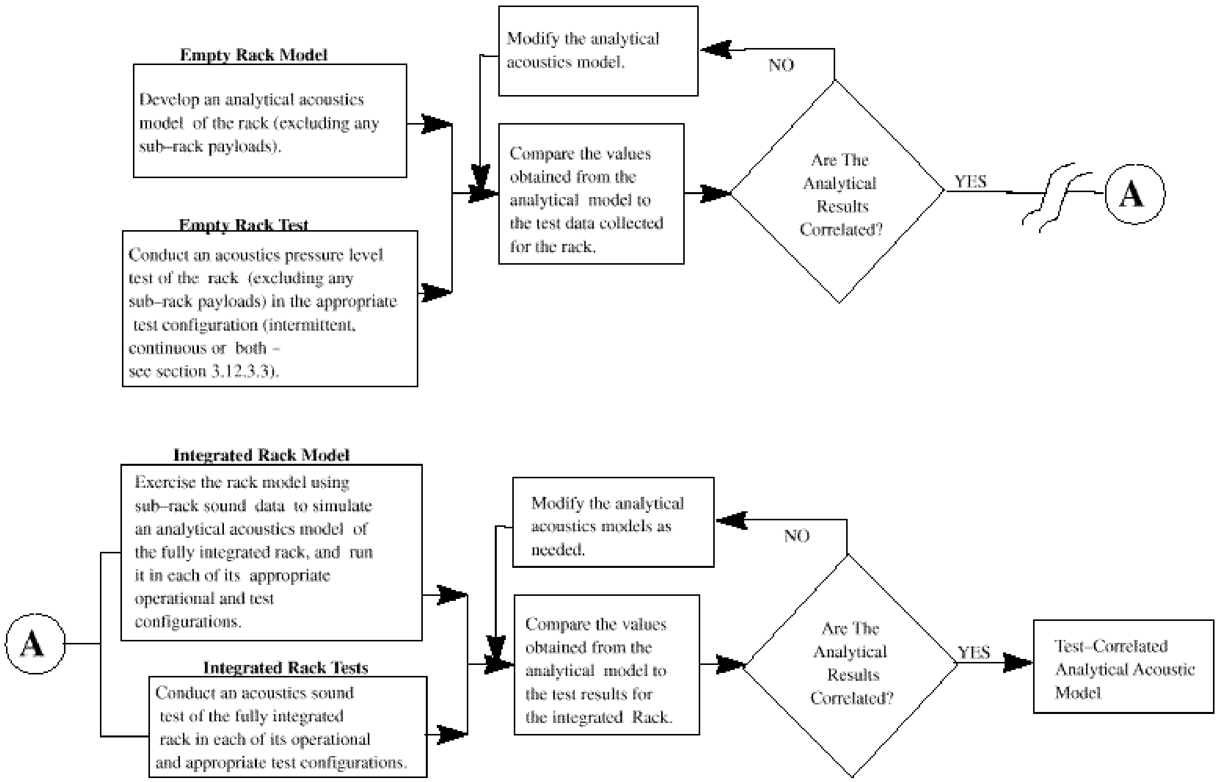


FIGURE 31. Test correlated model process

TABLE XIX. Continuous noise limits

Rack Noise Limits Measured At 0.6 Meters Distance From The Test Article	
Frequency Band Hz	**Integrated Rack Sound Pressure Level (SPL)**
63	64
125	56
250	50
500	45
1000	41
2000	39
4000	38
8000	37

TABLE XX. Intermittent noise limits

Rack Noise Limits Measured at 0.6 meters distance from the test article	
Maximum Rack Noise Duration Ü	**Total Rack A-weighted SPL (dBA)**
8 Hours	49
7 Hours	50
6 Hours	51
5 Hours	52
4 Hours	54
3 Hours	57
2 Hours	60
1 Hour	65
30 Minutes	69
15 Minutes	72
5 Minutes	76
2 Minutes	78
1 Minute	79
Not Allowed	80

When the intermittent sound occurs (a description of what payload activities/operations produce intermittent sound), i.e. a compressor turning on.

1. Duration and SPL (maximum A-weighted SPL measured at a 0.6-m distance from the loudest part of the equipment).
2. A projected mission timeline(s) (a typical SAR scenario that would produce intermittent sound).

The verification shall be considered successful when the results from the test-correlated analytical model predict the A-weighted noise level of the SAR for the maximum rack noise duration to be at or below the levels specified in Table XX.

4.8.7.9 SAR hardware mounting.

4.8.7.9.1 Equipment mounting.

Equipment mounting used during nominal operations and planned maintenance shall be verified by analysis or demonstration. The verification shall be considered successful when the analysis or demonstration shows that the SAR hardware used during nominal operations and planned maintenance is designed, labeled, or marked to protect against improper installation.

4.8.7.9.2 Drawers and hinged panel.

Drawers and hinged panels shall be verified by analysis. Verification shall be considered successful when an analysis of the equipment flight drawings shows that any SAR assembly that has to be removed is mounted on equipment drawers or hinged panels and remains in the open position without being supported by the hand.

4.8.7.9.3 Alignment.

Alignment shall be verified by analysis. Verification shall be considered successful when an analysis of the SAR flight hardware drawings shows that guide pins or their equivalent are provided to assist in alignment during installation of hardware with blind mate connectors.

4.8.7.9.4 Slide-out stops.

Slide-out stops shall be verified by inspection, analysis, or demonstration. Verification shall be considered successful when an inspection or analysis of the drawings or demonstration of the SAR flight hardware shows that limit stops are provided on slide or pivot mounted assemblies which are required to be pulled out of their installed positions.

4.8.7.9.5 Push-pull force.

Push-pull forces shall be verified by analysis. Verification shall be considered successful when an analysis of the SAR flight hardware shows that hardware mounted into a capture-type receptacle that requires push-pull action requires a force less than 156 N (35 lbf) to install and remove.

4.8.7.9.6 Access.

Access to inspect or replace a hardware item which is planned to be accessed on a daily or weekly basis shall be verified by analysis or demonstration. Verification shall be considered successful when an analysis of the SAR flight hardware drawings or a demonstration of the SAR flight hardware shows that hardware items which are planned to be accessed on a daily or weekly basis can be inspected and replaced without requiring the removal of an assembly or more than one access cover.

4.8.7.9.7 Covers.

An analysis of SAR hardware and flight drawings shall be performed to verify:

a. Provide a sliding or hinged cap or door where debris, moisture, or other foreign materials might otherwise create a problem.
b. Provide a quick-opening cover plate if a cap will not meet stress requirements.

The verification shall be considered successful when the analysis shows the requirements have been met.

4.8.7.9.8 Self-supporting covers.

Self-supporting covers shall be verified by analysis. Verification shall be considered successful when an analysis of the SAR flight hardware drawings shows that all access covers that are not completely removable are self-supporting in the open position.

4.8.7.9.9 Unique tools.

Unique tools shall be verified by analysis. Verification shall be considered successful when an analysis of the SAR flight hardware drawings meets the requirements of SSP 50005, paragraph 11.2.3.

4.8.7.10 Connectors.

4.8.7.10.1 One-handed operation.

One-handed operation shall be verified by analysis or demonstration. The analysis or demonstration shall be performed on the drawings or flight hardware which replicates the flight configuration. Verification shall be considered successful when the analysis or demonstration shows that all connectors can be mated/demated using only one hand, which does not preclude the use of either hand.

4.8.7.10.2 Accessibility.

a.
   1. Nominal Operations – Accessibility shall be verified by analysis or demonstration. Verification shall be considered successful when an analysis of the SAR flight hardware drawings or demonstration of the SAR flight hardware shows that it is possible to mate/demate individual connectors without having to remove or mate/demate other connectors.
   2. Maintenance Operations – Accessibility shall be verified by analysis or demonstration. Verification shall be considered successful when an analysis of the SAR flight hardware drawings or demonstration of the SAR flight hardware shows that it is possible to mate/demate individual connectors without having to remove or mate/demate connectors on other assemblies or payloads.

b. Accessibility shall be verified by analysis. Verification shall be considered successful when an analysis of the SAR hardware drawings shows that it is possible to disconnect and reconnect electrical connectors and cable installations without damage to wiring connectors.

4.8.7.10.3 Ease of disconnect.

a. Ease of disconnect shall be verified by analysis. Verification shall be considered successful when the analysis shows that electrical connectors which are mated/demated during nominal operations require no more than two turns to disconnect.
b. Ease of disconnect shall be verified by analysis. Verification shall be considered successful when the analysis shows that electrical connectors which are mated/demated only during assembly replacement operations require no more than six turns to disconnect.

4.8.7.10.4 Indication of pressure/flow.

Indication of pressure/flow shall be verified by analysis. Verification shall be considered successful when analysis of SAR flight hardware drawings shows that SAR liquid or gas lines not equipped with quick disconnect connectors which are designed to be connected/disconnected under pressure are fitted with pressure/flow indicators.

4.8.7.10.5 Self locking.

Self locking shall be verified by analysis. Verification shall be considered successful when an analysis of SAR flight hardware drawings shows SAR electrical connectors are provided with a self-locking feature.

4.8.7.10.6 Connector arrangement.

a. Connector arrangement shall be verified by inspection. Verification shall be considered successful when an inspection of the space between connectors and adjacent obstructions comply with the requirement.
b. Connector arrangement shall be verified by inspection. Verification shall be considered successful when an inspection of connectors in a single row or staggered rows complies with the requirements.

4.8.7.10.7 Arc containment.

Arc containment shall be verified by analysis. Verification shall be considered successful when an analysis of the SAR flight hardware drawings shows that electrical connector plugs confine/isolate the mate/demate electrical arcs or sparks.

4.8.7.10.8 Connector protection.

Connector protection shall be verified by analysis. Verification shall be considered successful when an analysis shows that protection is provided for all demated connectors against physical damage and contamination.

4.8.7.10.9 Connector shape.

Connector shape shall be verified by analysis. Verification shall be considered successful when an analysis of SAR flight hardware drawings shows that connectors which differ in content are of different shape or are physically incompatible.

4.8.7.10.10 Fluid and gas line connectors.

The inspection of fluid and gas line connectors that are mated and demated on-orbit shall be verified by analysis. Verification shall be considered successful when an analysis of SAR flight hardware drawings shows that fluid and gas connectors that are mated and demated on-orbit are located and configured so that they can be fully inspected for leakage.

4.8.7.10.11 Alignment marks or pin guides.

Alignment marks or guide pins on mating parts shall be verified by inspection. Verification shall be considered successful when an inspection shows that mating parts have alignment marks in a visible location during mating or guide pins (or their equivalent).

4.8.7.10.12 Orientation.

Orientation shall be verified by analysis. Verification shall be considered successful when an analysis of the SAR flight hardware drawings shows that grouped plugs and receptacles are oriented so that the aligning pins or equivalent devices are in the same relative position.

4.8.7.10.13 Hose/cable restraints.

a. Hose/cable restraints shall be verified by inspection. Verification shall be considered successful when an inspection shows that the loose ends of hoses and cables have a means of being restrained.
b. Hose/cable restraints shall be verified by inspection. Verification shall be considered successful when an inspection shows that conductors, bundles, or cables are secured by a means of clamps unless they are contained in wiring ducts or cable retractors.
c. NVR.
d. Hose/cable restraints shall be verified by inspection. Verification shall be considered successful when an inspection shows that loose cables are restrained as specified.

4.8.7.11 Fasteners.

4.8.7.11.1 Non-threaded fasteners status indication.

Non-threaded fastener status indication shall be verified by demonstration or inspection. Verification shall be considered successful when demonstration or inspection shows that an indication of correct engagement (hooking, latch fastening, or proper positioning of interfacing parts) of non-threaded fasteners shall be provided.

4.8.7.11.2 Mounting bolt/fastener spacing.

Mounting bolt/fastener spacing shall be verified by inspection. Verification shall be considered successful when an inspection shows that mounting bolts and fasteners are spaced as specified.

4.8.7.11.3 Multiple fasteners.

Multiple fasteners shall be verified by inspection. Verification shall be considered successful when an inspection shows that when several fasteners are used on one item they are all of identical type.

4.8.7.11.4 Captive fasteners.

Captive fasteners shall be verified by analysis. Verification shall be considered successful when an analysis shows that fasteners planned to be installed and/or removed on orbit are captive when disengaged.

4.8.7.11.5 Quick release fasteners.

a. Quick release fasteners shall be verified by inspection. Verification shall be considered successful when an inspection shows that fasteners require a maximum of one complete turn to operate.
b. Quick release fasteners shall be verified by inspection. Verification shall be considered successful when an inspection shows that fasteners are positive locking in open and closed positions.

4.8.7.11.6 Threaded fasteners.

Threaded fasteners shall be verified by inspection. The inspection shall be of the drawings. Verification shall be considered successful when the inspection shows that all threaded fasteners are right handed.

4.8.7.11.7 Over center latches.

a. Over center latches shall be verified by inspection. Verification shall be considered successful when an inspection shows that there is a provision to prevent undesired latch element realignment, interface, or reengagement.
b. Over center latches shall be verified by inspection. Verification shall be considered successful when an inspection shows that latch catches have locking features.
c. Over center latches shall be verified by inspection. Verification shall be considered successful when an inspection shows that the latch handle and latch release are operable by one hand.

4.8.7.11.8 Winghead fasteners.

Winghead fasteners shall be verified by inspection. Verification shall be considered successful when an inspection shows that winghead fasteners fold and are retained flush with surfaces.

4.8.7.11.9 Fasteners head type.

a. The hex type external or internal grip or combination head fastener type shall be verified by inspection. The inspection shall be of the hardware or the drawings and parts list. Verification shall be considered successful when an inspection shows that the hex type external or internal grip or combination head fasteners are used for all on-orbit crew actuated equipment.
b. The use of flush or oval head internal hex grip fastener head type on smooth surfaces shall be verified by inspection. The inspection shall be of the hardware or the drawings and parts list.

Verification shall be considered successful when an inspection shows that, when a smooth surface is required, only flush or oval head internal hex grip fastener head types are used.

c. The verification that straight-slot fasteners are not used to carry launch loads for hard-mounted equipment shall be by inspection. The inspection shall be of the hardware or the drawings and parts list. Verification shall be considered successful when an inspection shows that straight-slot fasteners are not being used to carry launch loads for hard-mounted equipment.

4.8.7.11.10 One-handed operation.

One-handed operation shall be verified by analysis or demonstration. The analysis or demonstration shall be performed on the drawings, flight hardware, or hardware which replicates the flight hardware configuration. Verification shall be considered successful when the demonstration shows that fasteners planned to be removed or installed on orbit can be mated/demated using only one hand, which does not preclude the use of either hand.

4.8.7.11.11 Access holes.

Access holes shall be verified by inspection. Verification shall be considered successful when an inspection shows that covers or shields though which mounting fasteners must pass for attachment to the basic chassis of the unit shall have holes for passage of the fastener without precise alignment.

4.8.7.12 Controls and displays.

4.8.7.12.1 Controls spacing design requirements.

Controls spacing design shall be verified by inspection. Verification shall be considered successful when the spacing between controls and adjacent obstructions is as specified.

4.8.7.12.2 Accidental actuation.

4.8.7.12.2.1 Protective methods.

Protective methods to reduce accidental actuation of controls shall be verified by inspection. Verification shall be considered successful when one or more of the conditions called out in subparagraphs a through g of FCF-SPC-0004, paragraph 3.3.7.12.2.1 are met.

4.8.7.12.2.2 Noninterference.

Noninterference shall be verified by inspection. Verification shall be considered successful when an inspection shows that protection devices do not cover or obscure other displays and controls.

4.8.7.12.2.3 Dead-man controls.

NVR.

4.8.7.12.2.4 Barrier guards.

Barrier guards shall be verified by inspection. Verification shall be considered successful when an inspection shows that the barrier guard spacing is as specified.

4.8.7.12.2.5 Recessed switch protection.

Recessed switch protection shall be verified by inspection. Verification shall be considered successful when an inspection shows that rotary switches that control critical functions, and do not have a barrier guard, are recessed as specified.

4.8.7.12.2.6 Position indication.

Position indication shall be verified by inspection. Verification shall be considered successful when an inspection shows that control position is evident without requiring cover removal.

4.8.7.12.2.7 Hidden controls.

Hidden controls shall be verified by inspection. Verification shall be considered successful when an inspection shows that hidden controls are guarded to protect against inadvertent actuation.

4.8.7.12.2.8 Hand controllers.

Hand controllers shall be verified by inspection. Verification shall be considered successful when an inspection shows that hand controllers have a separate on/off control.

4.8.7.13 Valve controls.

a. Low-torque valve controls shall be verified by inspection. Verification shall be considered successful when an inspection of the SAR flight hardware drawings of valves classified as low-torque are equipped with a central pivot type handle as specified.
b. Intermediate-torque valve controls shall be verified by inspection. Verification shall be considered successful when an inspection of the SAR flight hardware drawings of valves classified as intermediate-torque are equipped with a central pivot or lever type handle as specified.
c. High-torque valve controls shall be verified by inspection. Verification shall be considered successful when an inspection of the SAR flight hardware drawings of valves classified as high-torque valves are equipped with a lever type handle as specified.
d. Handle dimensions shall be verified by inspection. Verification shall be considered successful when an inspection of SAR flight hardware drawings is as specified.
e. Rotary valve controls shall be verified by inspection. Verification shall be considered successful when an inspection shows that rotary valve controls open the valve with a counterclockwise motion.

4.8.7.14 Toggle switches.

Toggle switches shall be verified by inspection. Verification shall be considered successful when an inspection of the flight article drawings is as specified.

4.8.7.15 Restraints and mobility aids.

The design of the SAR shall be verified by demonstration or analysis. Verification shall be considered successful when the SAR installation, operation, and maintenance tasks can be performed using standard crew restraints, mobility aids, and interfaces as specified. The demonstration or analysis shall show adequate clearance for attaching RMA's in a position that 95% and 5% crew can reach and is oriented to perform the installation, operation, and maintenance tasks.

4.8.7.16 Captive parts.

Captive parts shall be verified by inspection. Verification shall be considered successful when an inspection shows that all unrestrained parts that are temporarily removed on orbit are held captive.

4.8.7.17 Handle and grasp area design requirements.

4.8.7.17.1 Handles and restraints.

Verification of portable equipment grasp capability shall be by demonstration or inspection. The demonstration shall utilize personnel with hand dimensions within 10% of Table <TBD 04-04> to demonstrate sufficient grasp capability is provided for the 5^{th} percentile female and 95^{th} percentile male. The inspection shall utilize drawings to verify that a handle or other suitable grasp area is provided for portable equipment. The demonstration or inspection shall be considered successful when it is shown that the portable equipment can be grasped by both 5^{th} percentile and 95^{th} percentile personnel using one hand.

4.8.7.17.2 Handle location/front access.

Handle location and access requirements shall be verified by inspection of the SAR drawings. Verification shall be considered successful when inspection of the flight hardware confirms compliance with the requirement.

4.8.7.17.3 Handle dimensions.

IVA handle dimensions for moveable or portable units shall be verified by analysis or demonstration. The verification shall be considered successful when demonstration of the flight hardware confirms compliance with the requirements.

4.8.7.17.4 Nonfixed handles design requirements.

a. Nonfixed handle stop position shall be verified by analysis and demonstration. The verification shall be considered successful when demonstration of the flight hardware confirms compliance with the requirement.
b. Verification of one-handed operation shall be done by demonstration. The verification shall be considered successful when demonstration of this requirement is met.
c. The incorporation of tactile and/or visual indication of locked/unlocked status shall be verified by inspection and demonstration. The verification shall be considered successful when demonstration of the flight hardware confirms compliance with the requirement.

4.8.8 Design requirements.

NVR.

4.8.8.1 Units of measure.

The SAR use of metric units as its primary unit of measure, except when interfacing with non-metric ISS equipment or lack of availability of metric components precludes it shall be verified by inspection of the SAR drawings and associated deviations and waivers. The verification shall be considered successful when the inspection of the drawings and associated deviations and waivers shows the SAR use of metric units as its primary unit of measure, except when interfacing with non-metric ISS equipment or lack of availability of metric components precludes it.

4.8.8.2 Margins of safety/factor of safety.

The design of the SAR use of factors of safety as specified in NSTS 1700.7: NSTS 1700.7, ISS Addendum: and SSP 52005 shall be verified by inspection of the related analysis documentation. The verification shall be considered successful when the inspection of the of the documentation relating to the design of the SAR uses factors of safety as specified in NSTS 1700.7: NSTS 1700.7, ISS Addendum: and SSP 52005.

4.8.8.3 Allowable mechanical properties.

Values for mechanical properties of structural materials in their design environment are taken in accordance with MIL-HDBK-05 and MIL-HDBK-27 using the "A" allowable shall be verified by inspection of the related SAR analyses. The verification shall be considered successful when the inspection of the SAR related analyses shows the values for mechanical properties of structural materials in their design environment are taken in accordance with MIL-HDBK-05 and MIL-HDBK-27 using the "A" allowable.

4.8.8.4 Fracture control.

The SAR structure meeting the fracture control requirements as specified in NASA-STD-5003 shall be verified by inspection of the related SAR analyses. The verification shall be considered successful when the inspection of the related analyses shows the SAR structure meeting the fracture control requirements as specified in NASA-STD-5003.

4.9 SAR computer resource requirements.

NVR.

4.9.1 SAR computer software design considerations.

a. The SAR primary processor capability to self-activate and self-test once power is applied to the SAR power interface shall be verified by test. Verification shall be considered successful when the test shows the SAR primary processor can self-activate and self-test once power is applied to the SAR power interface.
b. The SAR integrity of all transmitted files shall be verified by experiment simulation testing. Verification shall be considered successful when experiment simulation tests show the SAR integrity of all transmitted files.
c. A single computer within the SAR coordinating all automated activities performed by the SAR shall be verified by test. The verification shall be considered successful when the test shows the single computer within the SAR coordinating all automated activities performed by the SAR.

4.9.1.1 Command and data requirements.

4.9.1.1.1 Word/byte notations.

Verification of the word/byte notations shall be by inspection. The inspection shall consist of a review of the word/byte notations against SSP 52050, paragraph 3.1.1 and SSP 57002, paragraph 3.1.1. Verification shall be considered successful when it is shown that the word/byte notations in the SAR software ICD conforms to SSP 52050, paragraph 3.1.1 and SSP 57002, paragraph 3.1.1.

4.9.1.1.2 Data types.

Verification of the data types shall be by inspection. The inspection shall consist of a review of the data types against SSP 52050, paragraph 3.2.1 and subparagraphs. Verification shall be considered successful when it is shown that the data types in the SAR software ICD conforms to SSP 52050, paragraph 3.2.1 and subparagraphs.

4.9.1.1.3 Data transmissions.

a. Verification of the low rate data link (LRDL) transmissions shall be by inspection. The inspection shall consist of a review of the LRDL data transmissions against D684-10056-01, paragraph 3.4. Verification shall be considered successful when it is shown that the word/byte notations in the SAR software ICD conforms to D684-10056-01, paragraph 3.4.
b. Verification of the medium rate data link (MRDL) transmissions shall be by inspection. The inspection shall consist of a review of the MRDL data transmissions against SSP

52050,paragraph 3.3.3.1. Verification shall be considered successful when it is shown that the word/byte notations in the SAR software ICD conforms to SSP 52050, paragraph 3.3.3.1.

c. Verification of the high rate data link (HRDL) transmissions shall be by inspection. The inspection shall consist of a review of the HRDL data transmissions against CCSDS 701.0-B-2, paragraph 1.6. Verification shall be considered successful when it is shown that the word/byte notations in the SAR software ICD conforms to CCSDS 701.0-B-2, paragraph 1.6.

4.9.1.1.4 Consultative committee for space data systems.

Verification of the CCSDS data for FCF-SPC-0004, subparagraphs 3.4.1.1.4 a, b, and c shall be by analysis or test. The analysis shall consist of a review of the CCSDS data in the software design documentation. The test shall consist of a data transmission with the PRCU and inspection of the transmitted data against the SSP 52050 formats. Analysis shall be considered successful when it is shown that in the software design documentation the integrated rack data which is transmitted space to ground is either CCSDS data packets or bitstream and the integrated rack data which is transmitted ground to space or to the payload MDM is CCSDS data packets. Test shall be considered successful when the PRCU correctly receives the CCSDS data.

4.9.1.1.4.1 CCSDS data packets.

Verification of the CCSDS data packet shall be by test. The test shall consist of a data transmission with the PRCU and inspection of the transmitted data against the SSP 52050 formats. Test shall be considered successful when the PRCU correctly receives the CCSDS data packets.

4.9.1.1.4.1.1 CCSDS primary header.

Verification of the CCSDS primary header shall be by test. The test shall consist of a data transmission with the PRCU and inspection of the transmitted data against the SSP 52050 formats. Test shall be considered successful when the PRCU correctly receives the CCSDS primary header.

4.9.1.1.4.1.2 CCSDS secondary header.

Verification of the CCSDS secondary header shall be by test. The test shall consist of a data transmission with the PRCU and inspection of the transmitted data against the SSP 52050 formats. Test shall be considered successful when the PRCU correctly receives the CCSDS secondary header.

4.9.1.1.4.1.3 CCSDS data field.

Verification of the CCSDS data field shall be by test. The test shall consist of a data transmission with the PRCU and inspection of the transmitted data against the SSP 52050 formats. Test shall be considered successful when the PRCU correctly receives the CCSDS data field.

4.9.1.1.4.1.4 CCSDS application process identification field.

Verification of the CCSDS APID field shall be by test. The test shall consist of a data transmission with the PRCU and inspection of the transmitted data against the SSP 52050 formats. Test shall be considered successful when the PRCU correctly receives the CCSDS APID field.

4.9.1.1.4.2 CCSDS time codes.

4.9.1.1.4.2.1 CCSDS unsegmented time.

Verification of the CCSDS unsegmented time shall be by test. The test shall consist of a data transmission with the PRCU and inspection of the transmitted data against the SSP 52050 formats. Verification shall be to test the integrated rack with the PRCU for correct test CCSDS unsegmented time.

4.9.1.1.4.2.2 CCSDS segmented time.

Verification of the CCSDS segmented time shall be by test. The test shall consist of a data transmission with the PRCU and inspection of the transmitted data against the SSP 52050 formats. Verification shall be to test the integrated rack with the PRCU for correct test CCSDS segmented time.

4.9.1.1.5 MIL-STD-1553B low rate data link (LRDL).

Verification of the MIL-STD-1553B LRDL shall be by test. The test shall consist of the SAR Payload Bus Remote Terminal and RT Validation Test Set, provided by ISS, used in the performance of a complete RT Validation in accordance with MIL-HDBK-1553 Notice 1 Appendix A to verify the design. The test shall be considered successful when the SAR Payload Bus Remote Terminal meets the RT Validation test as specified.

4.9.1.1.5.1 Standard messages.

Verification of the standard messages shall be by inspection and test. The test shall consist of the PRCU transmitting and receiving standard messages with the SAR. Test shall be considered successful when the PRCU correctly receives the standard messages.

4.9.1.1.5.2 Commanding.

Verification of the commanding shall be by test. The test shall consist of the PRCU issuing commands to the SAR. Test shall be considered successful when the SAR correctly responds to the commands issued by the PRCU.

4.9.1.1.5.3 Health and status data.

Verification of the health and status data shall be by test and inspection. The test shall consist of the reception to the PRCU of the SAR health and status data. The SAR health and status data shall be tested during checkout with the Payload Rack Checkout Unit (PRCU), the Suitcase Test Environment for Payloads (STEP), or equivalent. The SAR health and status data shall be transmitted into the PRCU, the STEP, or equivalent and logged. Subsequent inspection of the logged data shall verify that it exists as defined in the SAR software ICD. Inspection shall be considered successful when it is shown that the health and status data in the SAR software ICD conforms to the format contained in SSP 52050, Table 3.2.3.5–1 and the data field format specified in SSP 57002, Table A–5. Test shall be considered successful when the PRCU, STEP, or equivalent correctly receives the health and status data as it is defined in the SAR software ICD.

4.9.1.1.5.4 Safety data.

Verification of the safety data shall be by test. The test shall consist of a transmission of a Class 2, Class 3, and Class 4 Caution and Warning messages and an inspection of the received data against the format of SSP 52050, paragraph 3.2.3.5; SSP 57002, Table A–1; and SSP 57002, Table A–5. Test shall be considered successful when the PRCU correctly receives the safety data.

4.9.1.1.5.5 Caution and warning.

4.9.1.1.5.5.1 Class 2 – warning.

Verification that the SAR formats the caution and warning (C&W) word for the listed warning events shall be by analysis and test. Analysis of the SAR safety hazard reports and SAR safety review data shall identify the types of events identified as warnings that are being monitored. The test shall use the STEP, PRCU, or equivalent to determine whether or not the C&W word in the SAR health and status is formatted as a warning for the events identified as warnings. Verification shall be considered successful when the analysis shows the C&W word is formatted in accordance with SSP 52050, paragraph 3.2.3.5 as a warning for events that are defined as a warning.

4.9.1.1.5.5.2 Class 3 – caution.

Verification that the SAR formats the C&W word for the listed caution events shall be by analysis and test. Analysis of the SAR safety hazard reports and SAR safety review data shall identify the types of events identified as cautions that are being monitored. The test shall use the STEP, PRCU, or equivalent to determine whether or not the C&W word in the SAR health and status is formatted as a caution for the events identified as cautions. Verification shall be considered successful when the analysis shows the C&W word is formatted in accordance with SSP 52050, paragraph 3.2.3.5 as a caution for events that are defined as a caution.

4.9.1.1.5.5.3 Class 4 – advisory.

Verification that the SAR requiring advisories format the C&W word for the listed advisory events shall be by analysis and test. Analysis of proposed SAR advisories shall identify the types of events identified as advisories. The test shall use the STEP, PRCU, or equivalent to determine whether or not the C&W word in the SAR health and status is formatted as an advisory for the events identified as advisories. Verification shall be considered successful when the analysis shows the C&W word is formatted in accordance with SSP 52050, paragraph 3.2.3.5 as an advisory for events that are defined as an advisory.

4.9.1.1.5.6 Service requests.

Verification of the service requests shall be by test. The test shall consist of the reception of the SAR's service request by the PRCU. Verification shall be to test the SAR with the PRCU for correct test service requests.

4.9.1.1.5.7 File transfer.

Verification of the file transfer data shall be by test. The test shall consist of a test for both the request to transfer and the actual transfer of a file with the PRCU. The transmitted file shall be inspected against the received file. Verification shall be to test the SAR with the PRCU for correct test file transfer.

4.9.1.1.5.8 Low rate telemetry.

Verification of low rate telemetry shall be by test. The test shall consist of a test of both the request to transmit and the transmission of low rate telemetry with the PRCU. The transmitted low rate telemetry shall be inspected against the received low rate telemetry. Verification shall be to test the SAR with the PRCU for correct low rate telemetry.

4.9.1.1.5.9 Defined mode codes.

Verification of the defined mode codes shall be by test. The test shall consist of the reception by the test equipment of the SAR Payload Bus Remote Terminal's response to a defined mode code transmitted by the test equipment. Test shall be considered successful when the SAR Payload Bus Remote Terminal correctly responds to the defined mode codes in an RT validation test as defined in MIL-HDBK-1553 Notice 1 Appendix A.

4.9.1.1.5.10 Implemented mode codes.

Verification of the implemented mode codes shall be by test. The test shall consist of the reception by the test equipment of the SAR Payload Bus Remote Terminal's response to an implemented mode code transmitted by the test equipment. Test shall be considered successful when the SAR Payload Bus Remote Terminal correctly responds to the implemented mode codes in a RT validation test as defined in MIL-HDBK-1553 Notice 1 Appendix A.

4.9.1.1.5.11 Illegal commands.

Verification of the illegal commands shall be by test. Verification shall be to test that the SAR Payload Bus Remote Terminal correctly responds to the illegal commands by setting the message error bit in the status word response in an RT validation test as defined in MIL-HDBK-1553 Notice 1 Appendix A. Verification shall be considered successful when the SAR Payload

Bus Remote Terminal sets the message error bit when the test equipment sends an illegal command.

4.9.1.1.5.12 LRDL interface characteristics.

a. Verification of P3 and P4 appropriate pinout assignment shall be by inspection. The inspection shall be an inspection of SAR drawings to verify that the P3 and P4 pinout matches the corresponding UIP J3 and J4 pinout respectively. The verification shall be considered successful when the inspection shows that the P3 and P4 connector pinout is appropriate.
b. Verification of the P3 and P4 connector with the requirements of SSQ 21635 shall be by inspection. The inspection shall consist of an inspection of the drawings to identify that the SSQ 21635 requirement is identified on the drawing for the P3 and P4 connectors. Verification shall be to test the integrated rack with the PRCU for correct test of the MIL-STD-1553B to receive and execute commands on P3 and P4 independently with various address assignments at P3 and P4.

4.9.1.1.5.12.1 Remote terminal hardwired address coding.

Verification of the RT hardwired address coding scheme (FCF-DOC-0002, paragraph 3.4.1.5.12.1 subparagraphs a - e) shall be by test. The test shall be performed with the PRCU or equivalent to determine that the SAR responds to all the assigned proper RT hardwired address for the ISPR locations. The test shall be considered successful if it demonstrates that the SAR responds only to the assigned RT hardwired address. Each assigned location shall be tested separately.

4.9.1.1.5.12.2 LRDL signal characteristics.

Verification of the MIL-STD-1553B bus A and bus B that the SAR meets the electrical characteristics in accordance with MIL-STD-1553B and the SAR MIL-STD-1553B terminal characteristics are in accordance with MIL-STD-1553B, paragraph 4.5.2 shall be by test. The test shall consist of the measurement of the LRDL signal characteristics with the RT Validation Test Set. Verification shall be to test the SAR Payload Bus Remote Terminal with RT Validation Test Set for correct test of the MIL-STD-1553B signal characteristics according to MIL-STD-1553B, paragraph 4.5.2 with a MIL-STD-1553B bus analyzer as specified in MIL-HDBK-1553 Notice 1 Appendix A.

4.9.1.1.5.12.3 LRDL cabling.

Verification of the SAR LRDL cable that the SAR MIL-STD-1553B internal wiring characteristics are according to SSQ 21655 for 75 Ω or equivalent, the SAR MIL-STD-1553B internal wiring characteristics are summarized in MIL-STD-1553B, Table 3.3.5.2.3–1, the SAR MIL-STD-1553B internal wiring stub length does not exceed 12 ft (3.65 m) when measured from the internal MIL-STD-1553B Remote Terminal to the ISPR Utility Interface Panel shall be by inspection. Verification shall be considered successful when it is shown that the SAR LRDL cable meets SSQ 21655 for 75 Ω or equivalent.

4.9.1.1.5.12.4 Multi-bus isolation.

Verification of the isolation between the various ISS Payload MIL-STD-1553B data buses shall be by test. The test shall consist of the measurement of the signal isolation between the multiple ISS Payload MIL-STD-1553B data buses of the SAR Payload Bus Remote Terminal in an RT validation test as defined in MIL-HDBK-1553 Notice 1 Appendix A. Verification shall be considered successful when the measurement of the signal isolation between the SAR Payload Bus Remote Terminal's multiple ISS Payload MIL-STD-1553B data buses is no less than 58 dB.

4.9.1.1.6 Medium rate data link (MRDL).

4.9.1.1.6.1 MRDL protocol.

Verification of the MRDL LAN 1 and LAN 2 shall be by inspection and test. Verification shall be by inspection of the SAR MRDL protocol to the SAR software ICD against SSP 52050 and SSP 57002. Verification shall be to test the SAR with the PRCU, for correct test of the MRDL protocol per the ISO/IEC 8802-3 Pics Proforma for 10-Base-T using an Ethernet network analyzer.

4.9.1.1.6.2 SAR protocols on the MRDL.

Verification of the SAR protocols length and format on the MRDL LAN 1 and LAN 2 conform with ISO/IEC 8802-3 10-Base-T protocol in accordance with SSP 52050, paragraph 3.3 and use the CCSDS protocol and gateway protocol in SSP 52050, paragraphs 3.3.4 and 3.3.7 shall be by inspection and test. Verification shall be by inspection of the SAR MRDL protocol to the SAR software ICD against SSP 52050 and SSP 57002. Verification shall be to test the SAR with the PRCU for correct test of the MRDL protocol per the ISO/IEC 8802-3 Pics Proforma for 10-Base-T using an Ethernet network analyzer.

4.9.1.1.6.3 MRDL address.

Verification of the SAR MRDL LAN 1 and LAN 2 unique address have a unique Institute of Electrical and Electronic Engineers (IEEE) issued physical address and the unique address is set prior to the Ethernet terminal going active shall be by inspection and test. Verification shall be by inspection of the SAR MRDL address to the SAR hardware ICD against SSP 57001. Verification shall be to test the SAR with the PRCU for correct test of the MRDL protocol per the ISO/IEC 8802-3 Pics Proforma for 10-Base-T using an Ethernet network analyzer.

4.9.1.1.6.4 SAR MRDL connectivity.

a. Verification of the SAR MRDL connectivity shall be by inspection. Inspection shall be considered successful when it is shown that the SAR drawings in the SAR ICD conform to SSP 57001, paragraph 3.3.3.1.
b. Verification of MRDL data routing shall be by test. The test shall be accomplished with the PRCU or equivalent. The test shall be considered successful when it is shown that MRDL data can be successfully routed to the proper ISS LAN with the correct MRDL address.

c. Internal MRDL verification shall be by test. The test shall be accomplished with the PRCU or equivalent. The test shall be considered successful when it is shown that isolation exists between the SAR internal LAN and the ISS LAN.
d. Verification shall be by analysis. The analysis shall verify that the unique numbers were issued by IEEE or their representative. Verification shall be considered successful when traceability of addresses to IEEE has been shown.

4.9.1.1.6.5 MRDL connector/pin assignments and wire requirements.

a. Verification of P46 and P47 appropriate pin assignment shall be by inspection. The inspection shall be an inspection of SAR drawings to verify that the P46 and P47 pinout matches the corresponding J46 and J47 pinout. The verification shall be considered successful when the inspection shows that the P46 and P47 connector pinout is appropriate.
b. Verification of the P46 and P47 connectors with the requirements of SSQ 21635 shall be by inspection. The inspection shall consist of an inspection of the drawings to identify that the SSQ 21635 requirement is identified on the drawing for the P46 and P47 connectors.
c. Verification of the P46 and P47 wires with the requirements of SSQ 21655 shall be by inspection. The inspection shall consist of an inspection of the drawings to identify that the 100-Ω SSQ 21655 requirement is identified on the drawing for the P46 and P47 wiring. Verification shall be to test the integrated rack with the PRCU for correct test of the MRDL to protocol on P46.

Verification shall be to test the SAR with the PRCU for correct test of the MRDL to protocol on P47.

4.9.1.1.6.6 MRDL signal characteristics.

Verification of the MRDL LAN-1 and LAN-2 signal characteristics shall be by inspection and test. Verification shall be by inspection of the integrated rack MRDL protocol to the SAR hardware ICD against SSP 57001. Verification shall be to test the SAR with the PRCU for correct test of the MRDL signal requirements per the ISO/IEC 8802-3 Pics Proforma for 10-Base-T using an Ethernet network analyzer.

4.9.1.1.6.7 MRDL cable characteristics.

Verification shall be by inspection of the SAR MRDL cable. Verification shall be considered successful when it is shown that the SAR MRDL cable meets SSQ 21655 for 100 Ω or equivalent.

4.9.1.1.6.7.1 Differential characteristic impedance.

Verification of the MRDL LAN-1 and LAN-2 differential characteristic impedance shall be by test. Verification shall be to test the SAR with the PRCU for correct test of the MRDL differential characteristic impedance in accordance with ISO/IEC 8802–3, paragraph 14.4.2.2.

4.9.1.1.7 SAR to high-rate frame multiplexer (HFM) protocols.

The SAR use of the HFM common protocols in accordance with SSP 50184, paragraph 3.3.2 shall be by test. Verification shall be considered successful when inspection of the data shows the use of the HFM common protocols in accordance with SSP 50184, paragraph 3.3.2.

4.9.1.1.7.1 High rate data link (HRDL) physical signaling data rates.

Verification of HRDL physical signaling shall be by test and analysis. Verification of the data rate being a multiple of 0.5 Mbps shall be by test at the SAR.

a. Verification of the SAR data rates is by test and is considered successful when the HRDL data rate is greater than or equal to 0.5 Mbps and less than or equal to the maximum negotiated data rate or 95.0 Mbps, whichever is less.
b. Verification of the SAR data rates is by test and is considered successful when the HRDL data rate is in increments of 0.5 Mbps. All selectable data rates are to be recorded.

4.9.1.1.7.2 Encoding.

Verification of the HRDL encoding shall be by inspection and test. Verification shall be by inspection of the integrated rack HRDL protocol to the SAR hardware ICD against SSP 50184 and SSP 57001. Verification shall be to test the SAR with the PRCU for correct test of the HRDL protocol.

4.9.1.1.7.3 SAR HRDL transmitted optical power.

Verification for the SAR design to transmit a HRDL signal in accordance with SSP 50184, paragraph 3.1.1 at an average optical power greater than -16.75 dBm and less than -8.3 dBm and the SAR transmitted optical power measured at the SAR P7 connector to the ISPR connector interface panel using the Halt symbol shall be to test the SAR with fiber optic power meter per ANSI X3.255, for correct optical power at using the Halt symbol. The perturbations optical power from the test setup are not included in the stated power requirement. The perturbations from the test are to be documented. This test shall be considered successful when the requirement is met or exceeded after the test setup variations are removed from the result.

4.9.1.1.7.4 HRDL fiber optic cable.

Verification shall be by inspection of the SAR HRDL cable. Verification shall be considered successful when it is shown that the SAR HRDL cable meets SSQ 21654 or equivalent.

4.9.1.1.7.5 HRDL fiber optic bend radius.

Verification shall be by inspection of the SAR HRDL cable routing, installation, and handling procedures. Verification shall be considered successful when the inspection shows that the routing, installation, and handling procedures do not cause the cable to be bent in a tighter radius.

4.9.1.1.7.6 HRDL connectors and fiber.

a. Verification of P7 appropriate pin assignment shall be by inspection. The inspection shall be an inspection of SAR drawings to verify that the P7 pinout matches the corresponding J7 pinout. The verification shall be considered successful when the inspection shows that the P7 connector pinout is appropriate.
b. Verification that the P7 connector meets the requirements of SSQ 21635 shall be by inspection. The inspection shall consist of an inspection of the drawings to identify that the SSQ 21635 requirement is identified on the drawing for the P7 connector.
c. Verification that the HRDL fiber meets the requirements of SSQ 21635 shall be by inspection. The inspection shall consist of an inspection of the drawings to identify that the SSQ 21635 requirement is identified on the drawing for the HRDL fiber.

4.9.1.1.8 Station support computer (SSC).

a. Verification shall be by inspection. The inspection shall be of flight drawings or hardware. The verification shall be considered successful when the inspection shows that each rack uses no more then one SSC.
b. SSC displays shall be verified by demonstration. The demonstration shall be performed on the flight hardware. Verification shall be considered successful when the demonstration to the Payload Display Review Panel (PDRP) shows the requirements in SSP 50313 have been met.

4.9.1.1.9 SAR national television systems committee (NTSC) video and audio interface requirements.

4.9.1.1.9.1 SAR NTSC video characteristics.

?Verification of this requirement is satisfied by performing the test requirement of 4.4.1.2.1. PFM NTSC Fiber Optic Video Characteristics and/or 4.4.1.3.1, NTSC Electrical Video Characteristics.?

4.9.1.1.9.2 Pulse frequency modulation NTSC fiber optic video characteristics.

?Verification of this requirement is satisfied by performing the test requirement of 4.4.1.2.1. PFM NTSC Fiber Optic Video Characteristics and/or 4.4.1.3.1, NTSC Electrical Video Characteristics.?

4.9.1.1.9.3 SAR NTSC PFM video transmitted optical power.

Verification shall be to test the SAR with fiber optic power meter. The perturbations of optical power from the test setup are not included in the stated power requirement. The perturbations from the test are to be documented. This test shall be considered successful when the requirement is met or exceeded after the test setup variations are removed from the result.

4.9.1.1.9.4 Fiber optic cable characteristics.

Verification shall be by inspection of the integrated rack fiber optic video cable. Verification shall be considered successful when it is shown that the integrated rack fiber optic video cable meets the requirements in FCF-DOC-0002, paragraph 3.4.1.1.9.5.

4.9.1.1.9.5 PFM NSTC video fiber optic cable bend radius.

Verification shall be by inspection of the integrated rack PFM NTSC video fiber optic cable routing, installation, and handling procedures. Verification shall be considered successful when the inspection shows that the routing, installation, and handling procedures do not cause the cable to be bent in a tighter radius.

4.9.2 Flexibility and expansion.

a. Verification that the SAR software be modifiable via the ISS communication network shall be by test using the PRCU. Verification shall be considered successful when the test shows SAR software can be modified via the ISS communication network using the PRCU.
b. SAR software modularized separate from PI-specific software shall be verified by analysis and test. Analysis verification shall be considered successful when the analysis shows the SAR software modularized separate from PI-specific software. Test verification shall be considered successful when the test shows that the SAR software is modularized separate from PI-specific software.
c. SAR software written in C++ and/or Java programming languages with the exception of COTS software and software classified as time critical shall be verified by inspection. Verification shall be considered successful when the inspection shows the SAR software is written in C++ and/or Java programming languages, with the exceptions as listed above.
d. The SAR capability to transfer internal bus controller (Master) functions from the primary processor to at least one other processor after SAR deployment shall be verified by demonstration using simulated SAR hardware. The verification shall be considered successful when the demonstration shows the SAR capability to transfer internal bus controller (Master) functions from the primary processor to at least one other processor.
e. The SAR throughput utilization of each computer communication bus not exceeding 60% of capacity of any 10-s period when connected to the SAR shall be verified by test. Verification shall be considered successful when the test shows the SAR thoughput utilization of each computer communication bus does not exceed 60% of capacity of any 10-s period when connected to the SAR.
f. The SAR volatile memory of all single board computers and associated circuit boards sized such that utilization cannot exceed 65% of the bytes available and 80% of the data read/write rates available when attached to the SAR shall be verified by analysis. Verification shall be considered successful when the analysis shows the SAR volatile memory of all single board computers and associated circuit boards is sized such that utilization cannot exceed 65% of the bytes available and 80% of the data read/write rates available when attached to the SAR.
g. The SAR nonvolatile memory of all single board computers and associated circuit boards sized such that utilization cannot exceed 80% of the bytes available and 70% of the data read/write rates available unless attached to the SAR shall be verified by analysis. Verification shall be considered successful when the analysis shows the SAR nonvolatile memory of all single board computers and associated circuit boards sized such that utilization

cannot exceed 80% of the bytes available and 70% of the data read/write rates available when attached to the SAR.

h. The SAR having all mass storage sized such that utilization cannot exceed 80% of the bytes available and 70% of the data read/write rates available for the particular mass storage, assuming data cannot be offloaded from mass storage during the conduct of an experiment when connected to the SAR shall be verified by analysis. The verification shall be considered successful when all SAR and FIR mass storage is sized such that utilization cannot exceed 80% of the bytes available and 70% of the data read/write rates available for the particular mass storage, assuming data cannot be offloaded from mass storage during the conduct of an experiment when connected to the SAR.

4.9.3 Software portability.

a. The SAR software design to facilitate migration for programs from systems supporting SAR development shall be verified by test. Verification shall be considered successful when the test shows the SAR software is designed to facilitate migration for programs from systems supporting SAR development using SAR development equipment.
b. The SAR software design to facilitate migration of programs to upgraded hardware and firmware shall be verified by test. Verification shall be considered successful when the test shows the SAR software is designed to facilitate migration of programs to upgraded hardware and firmware using SAR development equipment.

4.9.4 Data date/time stamps.

a. All data date/time stamped as specified in FCF-SPC-0004, paragraph 3.2.1.7 by the primary computer collecting the data shall be verified by inspection and test. The verifications shall be considered successful when the inspection of test data shows all data date/time stamped as specified in FCF-SPC-0004, paragraph 3.2.1.7 by the primary computer collecting the data.
b. Data flowing from one computer to another where date/time stamps have been applied not having their date/time stamps overwritten shall be verified by inspection and test. The verifications shall be considered successful when inspection of the test data shows data flowing from one computer to another where date/time stamps have been applied not having their date/time stamps overwritten.

4.10 Logistics.

4.10.1 Maintenance.

The SAR design to allow for changeout, maintenance, and upgrade of hardware and software to conduct the basis experiments as specified in FCF-DOC-002 shall be verified by demonstration. The verification shall be considered successful when the demonstration shows the SAR is designed to allow for changeout, maintenance, and upgrade of hardware and software to conduct the basis experiments as specified in FCF-DOC-002 using flight hardware simulators.

4.10.2 Supply.

The SAR design to perform a minimum of 5 basis-type experiments per year as specified in FCF-DOC-002 using no more than the up-mass and stowage volume resupply requirements as specified in FCF-DOC-0002, paragraph 3.2.2 shall be verified by analysis. The verification shall be considered successful when the analysis shows the SAR is designed to perform a minimum of 5 basis-type experiments per year as specified in FCF-DOC-002 using no more than the up-mass and stowage volume resupply requirements as specified in FCF-DOC-0002, paragraph 3.2.2.

4.10.3 Facilities and facility equipment.

Not applicable.

4.11 Personnel and training.

4.11.1 Personnel.

a. The SAR design to be nominally maintained and operated by one crew member shall be verified by demonstration. The verification shall be considered successful when the demonstration shows the SAR is designed to be nominally maintained and operated by one crew member.
b. The SAR design to be operated using ground commands once experiment setup is completed by the crew shall be verified by test. Verification shall be considered successful when the test shows the SAR is designed to be operated using ground commands once experiment setup is completed by the crew.
c. The SAR design such that no more than two crew members are required for off-nominal and troubleshooting operations shall be verified by demonstration. Verification shall be considered successful when the demonstration shows the SAR is designed such that no more than two crew members are required for off-nominal and troubleshooting operations.

4.11.2 Training.

The SAR design for simple and logical installation, maintenance, and operation to minimize crew training shall be verified by demonstration. Verification shall be considered successful when the demonstration shows the SAR design for simple and logical installation, maintenance, and operation to minimize crew training.

4.12 Major component characteristics.

Verification that the SAR assemblies listed in FCF-DOC-0002, paragraphs 3.1.6 and 3.1.9 are in accordance with their individual product specification shall be verified by inspection of each assembly's acceptance data package.

4.13 Preparation for delivery.

4.13.1 Preservation.

Not applicable.

4.13.2 Packing.

Packaging, handling, and transportation in accordance with NHB 6000.1 shall be verified by inspection. The verification shall be considered successful when the inspection shows packaging, handling, and transportation in accordance with NHB 6000.1.

4.13.2.1 Launch configured SAR.

The SAR in its launch configuration, including stowage items required to complete the on-orbit configuration, considered as Class I as specified in NHB 6000.1 shall be verified by inspection. The verification shall be considered successful when the SAR in its launch configuration, including stowage items required to complete the on-orbit configuration, is considered as Class I as specified in NHB 6000.1.

4.13.2.1.1 Cleanliness.

All surfaces of all hardware cleaned to the Visibly Clean - Sensitive (VC - S) cleanliness level as specified in SN-C-0005, except for those surfaces that are covered to maintain cleanliness for oxygen usage, shall be verified by inspection. The verification shall be considered successful when all surfaces of all hardware are cleaned to the VC - S cleanliness level as specified in SN-C-0005, except for those surfaces that are covered to maintain cleanliness for oxygen usage.

4.13.2.1.2 Procedures.

All flight hardware packed according to its specific packing procedures in the designated containers shall be verified by inspection. The verification shall be considered successful when all flight hardware is packed according to its specific packing procedures in the designated containers.

4.13.2.2 Flight spares and other equipment.

Spares and all other SAR equipment considered as Class III or higher as specified in NHB 6000.1 shall be verified by inspection. The verification shall be considered successful when spares and all other SAR equipment are considered as Class III or higher as specified in NHB 6000.1.

4.13.3 Marking and labeling.

Not applicable.

4.13.4 Marking for shipment.

Marking of packaging containing pressurized gases and chemicals in accordance with Department of Transportation regulations shall be verified by inspection. The verification shall be considered successful when marking of packaging containing pressurized gases and chemicals is in accordance with Department of Transportation regulations.

5.0 NOTES

There are no notes at this time.

APPENDIX A VERIFICATION DEFINITION SHEETS

A.1 Scope.

This section gives the description of the Verification Data Sheet.

A.2 VDS Description.

<table>
<tr><td>A Number
AA-NNN</td><td colspan="2">B Title
Example VDS</td><td>C Method
A/D/I/T</td><td>D Hazard Report(s)
Unique PVP only</td></tr>
<tr><td colspan="5">E Document No, Section Number(s), Title(s), and Method(s):
Applicable Document Section requirements.</td></tr>
<tr><td colspan="5">F Requirement:
The requirement that must be verified to ensure hardware/software compliance.</td></tr>
<tr><td colspan="5">G Detailed Descriptions of Requirements:
Instructions and details suggesting how the verification method(s), as identified in the header, should be implemented (what analyses, tests, inspections, or demonstrations are required and implementation details). In addition, any related clarification deemed necessary to further explain what is required will be provided.</td></tr>
<tr><td colspan="4">H Required Verification Data:
Data that is required to be submitted showing compliance to the verification requirement.</td><td>I Data Submittal Dates:
Date the data is to be submitted to meet project schedule.</td></tr>
<tr><td colspan="2">J Description of Reverification Requirements:</td><td colspan="2">K Reverification Method:
A/D/I/T</td><td>L Hazard Report(s):
Unique PVP only</td></tr>
<tr><td colspan="5">I. Description of the requirement that must be accomplished prior to on-orbit relocation of the integrated rack.
II. Description of the requirement that must be accomplished prior to on-orbit sub-rack P/L changeout (new, re-flight, or series) of the integrated rack.</td></tr>
<tr><td colspan="4">M Required Reverification Data:
I. Submittal data required for item I above.
II. Submittal data required for item II above.</td><td>N Data Submittal Dates:
I. Date the data is to be submitted to meet project schedule.
II. Date the data is to be submitted to meet project schedule.</td></tr>
<tr><td colspan="5">O Applicable Document(s):
Listing of any documents that are applicable to the identified verification requirement.</td></tr>
</table>

FIGURE 32. Example VDS

A.2.1 VDS header.

The header is used for identification and tracking purposes and contains blocks A through D:

a. Number

   1. 2.
   AA – NNN

   1. Discipline Identifier [2 digits (alphanumeric)]
      - ST - Structural
      - ME - Mechanical (include Human Factors)
      - EL - Electrical
      - CD - Command and Data Handling (Command & Data Handling and audio/video)
      - FD - Fluid Dynamics (Thermal Control, Vacuum, and Gases)
      - EN - Environmental
      - MP - Materials and Parts
      - SA - Safety (This category is for use by the Payload Developer (PD) to address generic and unique safety requirements in their Unique PVP's.)
      - FN - Functionality (performance) Related (Requirements in this category are the responsibility of the PD as coordinated with Payload Integration Management.)

      Note: Requirements in Categories SA and FN are not within the scope of this plan but are included for completeness. They are the responsibility of the PD (with appropriate guidance from Payload Integration Management and Program Safety Engineers). They shall be incorporated into the Unique PVP. Data submittals for any SA and FN VDS's are not required by ISS Payload Engineering and Integration (PEI).

   2. Numerical Sequence NNN [3 digits (numeric)]
      Use all digits – 001, 002, etc. This number represents sequential numbering of VDS's driven by the discipline. Example: ST-003. This example would be the third VDS within the structures discipline.

b. Title

The requirement title is a category identification of the design requirement and is derived from the requirements document requirement paragraph title. If the verification requirement covers more than one requirement, a general statement is provided.

c. Method

   There are four unique methods of verifying a design requirement: analysis (A), test (T), inspection (I), and demonstration (D). Each VDS will identify the required method of verification by indicating the method letter identifier or a combination of identifiers, if more than one methods applies.

   1. Test
      Test is actual operation of equipment, normally instrumented, under simulated or flight equivalent conditions or the subjection of parts or equipment to specified environments to measure and record responses in a quantitative manner. (Flight hardware will be required

for all tests unless the use of hardware, which replicates flight hardware is specifically identified on the VDS.)

2. Analysis
   Analysis is the technical evaluation process of using techniques and tools, such as mathematical models and computer simulations, historical/design/test data, and other quantitative assessments to calculate characteristics and verify specification compliance. Analysis is used to verify requirements where established techniques are adequate to yield confidence or where testing is impractical.

3. Inspection
   Inspection is a physical measurement or visual evaluation of equipment and associated documentation. Inspection is used to verify construction features, drawing compliance, workmanship, and physical condition. (Flight hardware will be required for all inspections unless the use of hardware, which replicates flight hardware is specifically identified on the VDS.)
   Note: Inspection in the context does not imply a Quality-Control type of activity.

4. Demonstration
   Demonstration is the qualitative determination of compliance with requirements by observation during actual operation or simulation under pre-planned conditions and guidelines. (Flight hardware will be required for all demonstrations unless the use of hardware, which replicates flight hardware is specifically identified on the VDS.)

d. Hazard Report(s) (This block can be used in the Unique PVP.)
   A Payload Hazard Report (PHR) identifies safety verification methods to ensure hazard controls will function/operate as intended. The PD is encouraged to identify the PHR(s) which include safety verification method(s) that are the same as the verification activity(ies) described on the VDS. This identification allows traceability between payload verification and safety verification used to control hazards. If the VDS is not related to safety, place "N/A" in the block.

A.2.2 VDS body.

The body of the VDS contains the following in blocks E through O: a summary statement of the applicable design requirement, the verification method description, and tasks to be accomplished to verify that the requirement has been satisfied. It also contains a description of the data that must be generated and delivered as proof of meeting the requirement and any applicable documentation and notes that may aid in accomplishing the verification.

e. Document Section Number(s), Title(s), and Method(s):
   This section contains a listing of the document section requirements that the VDS addresses.

f. Requirement Summary:
   A summary statement of the intent of the document requirements that the VDS addresses.

g. Detailed Descriptions of Requirements:
   This section includes instructions and details suggesting how the verification method(s) identified in the header should be implemented (what analyses, tests, inspections, or

demonstrations are required and implementation details). In addition, any related clarification deemed necessary to further explain what is required will be provided.

h. Required Verification Data:
The results of verification activities shall be documented. All supporting documentation will be retained and provided by the PD upon request. Data that is required to be submitted will be identified on the VDS. Data submittals specified herein do not relieve the PD from reports required to support program and design reviews. The three categories of submittal data are defined below and the VDS will identify which category is acceptable to demonstrate compliance with the verification requirement.

1. Certificate of Compliance
A Certificate of Compliance (COC) is a memorandum from a PD certifying that the hardware and/or software complies with the applicable VDS requirement. Multiple VDS's may be combined on a single COC. It should also state that the supporting data will be maintained by the PD and provided upon request. A COC can be used to address analysis, test, inspection, and demonstration verification methods. An example is given in Appendix B.

2. Data Certification
A Data Certification is a memorandum from a PD that certifies that the requirements identified on the referenced VDS have been met and provides the required summary results. It should also state that the supporting data will be maintained by the PD and provided upon request. The Data Certification will provide the following information:

- Statement of fact concerning the completion of the applicable analysis or test.
- Completion date of the analysis or test.
- Identification of the report containing the results of the analysis or test (i.e., Title and Number).
- Summary statement including the results of the analysis or test (e.g., margins of safety summary table or an isolation measurement).

An example is given in Appendix B.

3. Detailed Data
Detailed analysis and test data per the data required section of each VDS. An example is given in Appendix B.

i. Data Submittal Dates:
This block contains the submittal dates for the required verification data. The submittal dates in this plan are in terms of Launch minus a number of months (i.e., L-6 would be Launch minus six months).

j. Description of Reverification Requirements:
The reverification section of the VDS currently describes the two scenarios that may require additional verification activities to be performed by the PD. The activities could include a complete or partial rework of the analysis, demonstration, inspection, and test requirements that were originally needed to show compliance with the VDS. When the PD has defined any on-orbit subrack payload component or rack subsystem planned activities, such as hardware

modifications, component changeout, or maintenance, reverification requirements will be established and included in the Unique PVP. The details of the reverification requirement and the required submittal data are documented on each VDS in Appendix A. The two reverification conditions are listed below.

1. On-orbit relocation of the integrated rack.
2. On-orbit subrack P/L changeout (new, reflight, or series) of the integrated rack. When the statement “Same as the Detailed Descriptions of Requirements identified above” is listed in this section, it means that the analysis, demonstration, inspection, or test identified in the original requirement must be redone.

k. Reverification Method:
This block contains the method(s) used for reverification.

l. Hazard Reports (this block can be used in the Unique PVP):
Same as block D.

m. Required Reverification Data:
This section of the VDS identifies the data that must be submitted to show compliance with the reverification requirement. When the statement “Same as the Required Verification Data identified above”, new COC’s, Data Certs, or detailed data must be submitted to show compliance with the reverification requirement.

n. Data Submittal Dates:
This block contains the submittal dates for the required reverification data. Any data submittals with a L+ date must be submitted prior to any on-orbit operations of the payload.

o. Applicable Document(s):
This section of the VDS lists any documents that are applicable to the requirements listed on the VDS.

APPENDIX B EXAMPLE SUBMITTAL FORMS

B.1 Scope.

The section gives examples of submittal forms required for ISS verification.

B.2 Form examples.

Certificate of Compliance (COC)
I hereby certify compliance with the verification requirements as specified in _____________. I also certify that the identified as-built hardware, per the current applicable Engineering Configuration List, was manufactured in accordance with the design drawings, parts lists, applicable waivers and deviations. All supporting data is valid, applicable, and complete. This data is maintained in our files and will be made available upon request.

Payload	VDS Number	Method	Applicable Document Rev. Date	Drawings, Parts Lists, Waivers, Deviations, Procedures, Etc. (Attach correlated list as needed)

____
Print Name/Signature/Date
Payload Developer Responsible Person
Organization

Data Certification

I hereby certify compliance with the verification requirements as specified in _____________. I also certify that the identified as-built hardware, per the current applicable Engineering Configuration List, was manufactured in accordance with the design drawings, parts lists, applicable waivers and deviations. All supporting data is valid, applicable, and complete. This data is maintained in our files and will be made available upon request.

Payload	VDS Number	Method	Applicable Document Rev. Date	Completion Date	Summary (Attach sheets as needed)

____

Print Name/Signature/Date
Payload Developer Responsible Person
Organization

<table>
<tr><td colspan="4">VERIFICATION TEST REPORT</td></tr>
<tr><td>PAYLOAD:</td><td>TEST ENGINEER:</td><td>TEST PROCEDURE USED:</td><td>DATE:</td></tr>
<tr><td colspan="4">ITEM TESTED (NAME, SERIAL NUMBER, PART NUMBER):</td></tr>
<tr><td colspan="4">OBJECTIVES OF THE TEST:</td></tr>
<tr><td colspan="4">DESCRIPTION OF TEST SETUP:</td></tr>
<tr><td colspan="4">TEST RESULTS (SUMMARY):</td></tr>
<tr><td colspan="4">CORRELATION OF TEST SEQUENCE TO VERIFICATION REQUIREMENTS:</td></tr>
<tr><td colspan="4">EXPLANATION OF ALL FAILURES AND CORRECTIVE ACTION TAKEN DURING TEST:</td></tr>
<tr><td colspan="2">SIGNATURE:</td><td colspan="2">QUALITY ASSURANCE REPRESENTATIVE:</td></tr>
<tr><td colspan="2">ORGANIZATION:</td><td colspan="2">DATE:</td></tr>
<tr><td colspan="2">DATE:</td><td colspan="2">CONTINUATION REFERENCE:</td></tr>
</table>

<table>
<tr><td colspan="4" align="center">VERIFICATION ANALYSIS REPORT</td></tr>
<tr><td>PAYLOAD:</td><td>ANALYST:</td><td>CONFIGURATION ANALYZED:</td><td>DATE:</td></tr>
<tr><td colspan="4">OBJECTIVE OF ANALYSIS:</td></tr>
<tr><td colspan="4">REQUIREMENTS SATISFIED:</td></tr>
<tr><td colspan="4">DESCRIPTION OF ANALYTICAL TECHNIQUE:</td></tr>
<tr><td colspan="4">ANALYSIS INPUT DATA (SUMMARY):</td></tr>
<tr><td colspan="4">TECHNICAL RESULTS:</td></tr>
<tr><td colspan="4">CONCLUSIONS:</td></tr>
<tr><td colspan="2">SIGNATURE:</td><td colspan="2">ORGANIZATION:</td></tr>
<tr><td colspan="2">DATE:</td><td colspan="2">CONTINUATION REFERENCE:</td></tr>
</table>

VERIFICATION INSPECTION REPORT			
PAYLOAD:	INSPECTOR:	PROCEDURE USED:	DATE:
ITEM INSPECTED (NAME, SERIAL NUMBER, PART NUMBER):			
OBJECTIVES OF THE INSPECTION:			
DESCRIPTION OF QUALITY CONTROL METHODS USED:			
RESULTS (SUMMARY):			
VERIFICATION REQUIREMENTS ADDRESSED:			
EXPLANATION OF ANOMALIES FOUND DURING INSPECTION:			
SIGNATURE:		QUALITY ASSURANCE REPRESENTATIVE:	
ORGANIZATION:		DATE:	
DATE:		CONTINUATION REFERENCE:	

<table>
<tr><th colspan="4">VERIFICATION DEMONSTRATION REPORT</th></tr>
<tr><td>PAYLOAD:</td><td>WITNESS:</td><td>PROCEDURE USED:</td><td>DATE:</td></tr>
<tr><td colspan="4">CONFIGURATION OF ITEM USED IN DEMONSTRATION:</td></tr>
<tr><td colspan="4">OBJECTIVES OF THE DEMONSTRATION:</td></tr>
<tr><td colspan="4">DESCRIPTION OF DEMONSTRATION PROCEDURE:</td></tr>
<tr><td colspan="4">RESULTS SUMMARY:</td></tr>
<tr><td colspan="4">VERIFICATION REQUIREMENTS ADDRESSED:</td></tr>
<tr><td colspan="4">PARTICIPANTS:</td></tr>
<tr><td colspan="2">SIGNATURE:</td><td colspan="2">ORGANIZATION:</td></tr>
<tr><td colspan="2">DATE:</td><td colspan="2">CONTINUATION REFERENCE:</td></tr>
</table>

APPENDIX C ACRONYMS AND ABBREVIATIONS

C.1 Scope.

This appendix lists the acronyms and abbreviations used in this document.

C.2 List of acronyms and abbreviations.

A	amperes
A_i	inherent availability
ac	alternating current
APID	application process identification
ARIS	Active Rack Isolation System
atm	atmospheres
BIT	built-in-test
C	centigrade, Celsius
cc	cubic centimeter
CCSDS	Consultative Committee for Space Data Systems
CIR	Combustion Integrated Rack
cm	centimeter
COF	Columbus Orbital Facility
CoFR	Certification of Flight Readiness
COTS	commercial-off-the-shelf
COU	Concept of Operations and Utilization
C&W	caution and warning
dB	decibels
dBm	decibels referenced to 1 mW
dc	direct current
DOORS	Dynamic Object Oriented Requirements System
EDU	Engineering Development Unit
EM	Engineering Model
EMC	electromagnetic compatibility
EMI	electromagnetic interference
EPCE	Electrical Power Consuming Equipment
EPCU	Electrical Power Control Unit
EPS	Electrical Power System
ESD	electrostatic discharge
F	Fahrenheit
F	Farad
FCF	Fluids and Combustion Facility
FCSD	
FCU	FOMA Control Unit
FEM	finite element modeling
FIR	Fluids Integrated Rack
freq.	Frequency
FSD	Force Spectral Density

ft	feet
g	gravity
GFCI	Ground Fault Circuit Interrupters
GIU	Ground Interface Unit
GPVP	Generic Payload Verification Plan
GRC	Glenn Research Center
grms	gravity-root mean square
GSE	Ground Support Equipment
GSRP	Ground Safety Review Panel
h	hour
HFM	high-rate frame multiplexer
HRDL	high rate data link
Hz	Hertz
ICD	Interface Control Document
IDD	Interface Definition Document
IEEE	Institute of Electrical and Electronic Engineers
in.	inches
IR	infrared
IRD	Interface Requirements Document
ISPR	International Standard Payload Rack
ISS	International Space Station
ITCS	Internal Thermal Control System
IVA	Intravehicular Activity
J	joules
K	Kelvin
kg	kilograms
kPa	kilopascals
KSC	Kennedy Space Center
LAN	local area network
lbf	pounds force
lbm	pounds per minute
lbs	pounds
LED	Light Emitting Diode
LISN	Line Impedance Simulation Network
LRDL	low rate data link
m	meter
M	Mega
Mbps	megabytes per second
MDM	Multiplexer-Demultiplexer
MDP	Maximum Design Pressure
MDT	mean delay time
mm	millimeter
MMCH/Y	mean maintenance crew hours per year
MPLM	Multi-Purpose Logistics Module
MRDL	medium rate data link
MRDOC	Microgravity Research, Development, and Operations Contract

MRPO	Microgravity Research Program Office
MTBM	mean time between failures
MTL	moderate temperature loop
MVP	Master Verification Plan
N	Newton
N/A	Not applicable
NASA	National Aeronautics and Space Administration
NIST	National Institute of Standards and Technology
nm	nanometer
oct.	octave
ORU	Orbital Replacement Unit
Pa	Pascals
PAR	Products Assurance Representative
PD	Payload Developer
PDRP	Payload Display Review Panel
PEI	Payload Engineering and Integration
PFE	Portable Fire Extinguisher
PFM	Pulse Frequency Modulation
PI	Principal Investigator
PIA	Payload Integration Agreement
PIN	Part Identification Number
P/L	payload
PMIVP	Program Master Integration Verification Plan
POST	Power On Self Test
PRCU	Payload Rack Checkout Unit
PRPD	Payloads Research Program Document
psi	pounds per square inch
psia	pounds per square inch absolute
PSRP	Payload Safety Review Panel
PT	picotesla
PUL	Portable Utility Light
PVP	Payload Verification Plan
PVPP	Payload Verification Program Plan
QD	quick disconnect
rev.	revision
RHA	Rack Handling Adapters
RMA	Restraints and Mobility Aids
rms	root mean square
RMSA	Rack Maintenance Switch Assembly
RPC	Remote Power Controller
RSC	Remote Service Center
RSS	root-sum-square
RT	Remote Terminal
RUP	Rack Utility Panel
RVP	Requirements Verification Plan
S	second

SAMS	Spacecraft Acceleration Measurement System
SAR	Shared Accommodations Rack
scc	standard cubic centimeter
SEA	Statistical Energy Analysis
SEE	single event effect
SPIP	Station Program Implementation Plan
SRD	Science Requirements Document
SRED	Science Requirements Envelope Document
SSC	Station Support Computer
STEP	Suitcase Test Environment for Payloads
TBD	To be determined
TCS	Thermal Control System
UIP	Utility Interface Panel
UOP	Utility Outlet Panel
US Lab	United States Laboratory Module
UV	ultraviolet
VC - S	Visibly Clean - Sensitive
Vdc	voltage direct current
VDS	Verification Definition Sheet
VES/WGS	Vacuum Exhaust System/Waste Gas System
Vib.	Vibratoy
W	watts
xfer	transfer
μ	micro
μg	microgravity
Ω	ohm

APPENDIX D TBD'S

D.1 Scope.

This appendix lists all items in this document that need to be determined (TBD).

D.2 List of TBD's.

Table XXI lists all the TBD's in this document.

TABLE XXI. TBD's

TBD Number	Description	Document Paragraph
04-01	SAR science heat rejection verification requirement	4.2.5
04-02	SAMS data interface information	4.2.9.7
04-03	Number of on-orbit MMCH/Y for scheduled and unscheduled maintenance activities	4.4
04-04	Number of Table that shows hand dimensions for sufficient grasp capability for the 5th percentile female and 95th percentile male	4.8.7.17.1
E-01	SAR science heat rejection verification requirement	E.2
E-02	SAMS data interface verification requirement	E.2
F-01	The SAR verification data sheets are not yet developed	F.2

APPENDIX E VERIFICATION CROSS REFERNENCE MATRIX

E.1 Scope.

This section contains the requirement/verification cross-reference matrix.

E.2 Requirement/verification cross-reference.

Verification Method:	
NA – Not Applicable	NVR – No Verification Required
I – Inspection	A – Analysis
D – Demonstration	T – Test

Paragraph Name	FCF-SPC-0004 Sec. 3 Req. Number	FCF-SPC-0004 Sec. 4 Req. Number	SAR-PLN-0007 Sec. 4 Req. Number	VDS No.	Verification Method
Performance characteristics	3.2.1	4.2.1	4.1	NA	I
Utilization	3.2.1.1	4.2.1.1	4.1.1	FN-001	A
Support other ISS/payload systems	3.2.1.2	4.2.1.2	4.1.2	FN-001	D & T
Science volume	3.2.1.3	4.2.1.3	4.1.3	FN-002	A & D
Science volume temperature	3.2.1.4	4.2.1.4	4.1.4	FN-003	T
Science acceleration and vibration	3.2.1.5	4.2.1.5	4.1.5	FN-004	A
Internal data transmission	3.2.1.6a	4.2.1.6a	4.1.6 a.	FN-005	T
Internal data transmission	3.2.1.6b	4.2.1.6b	4.1.6 b.	FN-005	I
Internal data transmission	3.2.1.6c	4.2.1.6c	4.1.6 c.	FN-005	A
Internal data transmission	3.2.1.6d	4.2.1.6d	4.1.6 d.	FN-005	I
Internal data transmission	3.2.1.6e	4.2.1.6e	4.1.6 e.	FN-005	D
Internal data transmission	3.2.1.6f	4.2.1.6f	4.1.6 f.	FN-005	T
Internal data transmission	3.2.1.6g	4.2.1.6g	4.1.6 g.	FN-005	I
Data time reference	3.2.1.7	4.2.1.7	4.1.7	FN-005	T
Data time reference for experiment events	3.2.1.7.1	4.2.1.7.1	4.1.7.1	FN-005	T
Data time reference for external events	3.2.1.7.2	4.2.1.7.2	4.1.7.2	FN-005	T
SAR multiple experiment operations	3.2.1.8	4.2.1.8	4.1.8	FN-001	A
On-orbit instrument calibration	3.2.1.9	4.2.1.9	4.1.9	FN-006	T

Paragraph Name	FCF-SPC-0004 Sec. 3 Req. Number	FCF-SPC-0004 Sec. 4 Req. Number	SAR-PLN-0007 Sec. 4 Req. Number	VDS No.	Verification Method
Replacement of on-orbit instruments	3.2.1.9.1	4.2.1.9.1	4.1.9.1	FN-006	D
Rack environment monitoring	3.2.1.10	4.2.1.10	4.1.10	FN-007	A & T
On-orbit data collection and transfer	3.2.1.11	4.2.1.11	4.1.11	FN-005	NVR
Processing and providing data	3.2.1.11.1a	4.2.1.11a	4.1.11.1 a.	FN-005	I & T
Processing and providing data	3.2.1.11.1b	4.2.1.11b	4.1.11.1 b.	FN-005	T
Processing and providing data	3.2.1.11.1c	4.2.1.11c	4.1.11.1 c.	FN-005	T
Processing and providing data	3.2.1.11.1d	4.2.1.11d	4.1.11.1 d.	FN-005	T
Processing and providing data	3.2.1.11.1e	4.2.1.11e	4.1.11.1 e.	FN-005	T
Processing and providing data	3.2.1.11.1f	4.2.1.11f	4.1.11.1 f.	FN-005	T
Processing and providing data	3.2.1.11.1g	4.2.1.11g	4.1.11.1 g.	FN-005	T
Processing and providing data	3.2.1.11.1h	4.2.1.11h	4.1.11.1 h.	FN-005	D
NTSC video	3.2.1.11.2a	4.2.1.11.1a	4.1.11.2 a.	FN-006	D
NTSC video	3.2.1.11.2b	4.2.1.11.1b	4.1.11.2 b.	FN-006	I
NTSC video	3.2.1.11.2c	4.2.1.11.1c	4.1.11.2 c.	FN-006	T
On-orbit data transfer within FCF	3.2.1.11.3	4.2.1.11.3	4.1.11.3	FN-006	T
Use of fiber optics	3.2.1.11.4	4.2.1.11.4	4.1.11.4	FN-007	I
On-orbit data transfer to portable media	3.2.1.11.5	4.2.1.11.5	4.1.11.5	FN-008	I & T
SAR health status monitoring	3.2.1.12	4.2.1.12	4.1.12	FN-009	T
SAR/FCF health status monitoring	3.2.1.12.1	4.2.1.12.1	4.1.12.1	FN-009	T
SAR/ISS health status monitoring	3.2.1.12.2	4.2.1.12.2	4.1.12.2	FN-009	T
SAR Commanding	3.2.1.13	4.2.1.13	4.1.13	NA	NVR
SCC Commanding	3.2.1.13.1	4.2.1.13.1	4.1.13.1	FN-010	T
Ground Commanding	3.2.1.13.2	4.2.1.13.2	4.1.13.2	FN-010	T
Manual inputs	3.2.1.13.3	4.2.1.13.3	4.1.13.3	FN-010	I
Commanding for problem propagation	3.2.1.13.4	4.2.1.13.4	4.1.13.4	FN-010	T
Upgrading of SAR maintenance items	3.2.1.14	4.2.1.14	4.1.14	FN-011	A
SAR reconfiguration	3.2.1.15a	4.2.1.15a	4.1.15 a.	FN-012	D
SAR reconfiguration	3.2.1.15b	4.2.1.15b	4.1.15 b.	FN-012	D
SAR reconfiguration	3.2.1.15c	4.2.1.15c	4.1.15 c.	FN-012	D
Control the SAR	3.2.1.16a	4.2.1.16a	4.1.16 a.	FN-010	T
Control the SAR	3.2.1.16b	4.2.1.16b	4.1.16 b.	FN-010	T
Control the SAR	3.2.1.16c	4.2.1.16c	4.1.16 c.	FN-010	T
Control the SAR	3.2.1.16d	4.2.1.16d	4.1.16 d.	FN-010	T

Paragraph Name	FCF-SPC-0004 Sec. 3 Req. Number	FCF-SPC-0004 Sec. 4 Req. Number	SAR-PLN-0007 Sec. 4 Req. Number	VDS No.	Verification Method
Physical characteristics	3.2.2	4.2.2	4.2	NA	NVR
SAR dimensional characteristics	3.2.2.1	4.2.2.1	4.2.1	NA	NVR
SAR launch envelope	3.2.2.1.1	4.2.2.1.1	4.2.1.1	FN-013	A & T
SAR on-orbit envelope	3.2.2.1.2	4.2.2.1.2	4.2.1.2	ME-059	A & T
SAR stowage volume	3.2.2.1.3	4.2.2.1.3	4.2.1.3	FN-014	A & T
SAR maintenance item stowage	3.2.2.1.4	4.2.2.1.4	4.2.1.4	FN-014	A & T
SAR weight characteristics	3.2.2.2 a.	4.2.2.2 a.	4.2.2 a.	ME-001	A & D
SAR weight characteristics	3.2.2.2 b.	4.2.2.2 b.	4.2.2 b.	ME-001	A & D
SAR weight characteristics	3.2.2.2 c.	4.2.2.2 c.	4.2.2 c.	ME-001	A & D
SAR power	3.2.2.3 a.	4.2.2.3 a.	4.2.3 a.	FN-015	A
SAR power	3.2.2.3 b.	4.2.2.3 b.	4.2.3 b.	FN-015	A
SAR environmental control system power allocation	3.2.2.3.1	4.2.2.3.1	4.2.3.1	FN-016	A & T
SAR power to PI equipment	3.2.2.3.2	4.2.2.3.2	4.2.3.2	FN-017	I & T
Power consumption during downlinking	3.2.2.3.3	4.2.2.3.3	4.2.3.3	FN-015	T
SAR heat rejection	3.2.2.4	4.2.2.4	4.2.4	FN-018	A
SAR science heat rejection	3.2.2.5	4.2.2.5	4.2.5	FN-018	<TBD E-01>
Thermal cooling water	3.2.2.6	4.2.2.6	4.2.6	FN-018	A & T
Durability	3.2.2.7 a.	4.2.2.7 a.	4.2.7 a.	FN-019	A
Durability	3.2.2.7 b.	4.2.2.7 b.	4.2.7 b.	FN-019	A
Transportation and safety requirements	3.2.2.8	4.2.2.8	4.2.8	NA	NA
Interfaces	3.2.2.9	4.2.2.9	4.2.9	NA	NA
Interfaces within the US Lab	3.2.2.9.1 a.	4.2.2.9.1 a.	4.2.9.1 a.	FN-020	D
Interfaces within the US Lab	3.2.2.9.1 b.	4.2.2.9.1 b.	4.2.9.1 b.	FN-020	D
Interfaces within the US Lab	3.2.2.9.1 c.	4.2.2.9.1 c.	4.2.9.1 c.	FN-020	I
Ground support equipment (GSE) interfaces	3.2.2.9.2 a.	4.2.2.9.2 a.	4.2.9.2 a.	FN-020	I
Ground support equipment (GSE) interfaces	3.2.2.9.2 b.	4.2.2.9.2 b.	4.2.9.2 b.	ME-051	D
Ground support equipment (GSE) interfaces	3.2.2.9.2 c.	4.2.2.9.2 c.	4.2.9.2 c.	ME-051	D
Ground support equipment (GSE) interfaces	3.2.2.9.2 d.	4.2.2.9.2 d.	4.2.9.2 d.	ST-007	T & A
MPLM interfaces	3.2.2.9.3 a.	4.2.2.9.3 a.	4.2.9.3 a.	ME-046	I

Paragraph Name	FCF-SPC-0004 Sec. 3 Req. Number	FCF-SPC-0004 Sec. 4 Req. Number	SAR-PLN-0007 Sec. 4 Req. Number	VDS No.	Verification Method
MPLM interfaces	3.2.2.9.3 b.	4.2.2.9.3 b.	4.2.9.3 b.	ST-003	A
MPLM interfaces	3.2.2.9.3 c.	4.2.2.9.3 c.	4.2.9.3 c.	ST-011	A
ISS fluids and vacuum interface requirement	3.2.2.9.4	4.2.2.9.4	4.2.9.4	NA	NA
Water Thermal Control System (WTCS)	3.2.2.9.4.1 a.	4.2.2.9.4.1 a.	4.2.9.4.1 a.	FD-002	T
Water Thermal Control System (WTCS)	3.2.2.9.4.1 b.	4.2.2.9.4.1 b.	4.2.9.4.1 b.	FD-002	A
Water Thermal Control System (WTCS)	3.2.2.9.4.1 c.	4.2.2.9.4.1 c.	4.2.9.4.1 c.	FD-003	T
Water Thermal Control System (WTCS)	3.2.2.9.4.1 d.	4.2.2.9.4.1 d.	4.2.9.4.1 d.	FD-004	A or T
Water Thermal Control System (WTCS)	3.2.2.9.4.1 e.	4.2.2.9.4.1 e.	4.2.9.4.1 e.	NA	NVR
Water Thermal Control System (WTCS)	3.2.2.9.4.1 f. (1)	4.2.2.9.4.1 f. (1)	4.2.9.4.1 f. (1)	FD-005	A & T
Water Thermal Control System (WTCS)	3.2.2.9.4.1 f. (2)	4.2.2.9.4.1 f. (2)	4.2.9.4.1 f. (2)	FD-005	A
Water Thermal Control System (WTCS)	3.2.2.9.4.1 f. (3)	4.2.2.9.4.1 f. (3)	4.2.9.4.1 f. (3)	FD-005	A & T
Water Thermal Control System (WTCS)	3.2.2.9.4.1 g.	4.2.2.9.4.1 g.	4.2.9.4.1 g.	ST-010	T
Water Thermal Control System (WTCS)	3.2.2.9.4.1 h.	4.2.2.9.4.1 h.	4.2.9.4.1 h.	FD-031	A
Water Thermal Control System (WTCS)	3.2.2.9.4.1 i.	4.2.2.9.4.1 i.	4.2.9.4.1 i.	FD-006	T
Water Thermal Control System (WTCS)	3.2.2.9.4.1 j.	4.2.2.9.4.1 j.	4.2.9.4.1 j.	FD-007	T or A
Water Thermal Control System (WTCS)	3.2.2.9.4.1 k.	4.2.2.9.4.1 k.	4.2.9.4.1 k.	FD-011	T
Water Thermal Control System (WTCS)	3.2.2.9.4.1 l.	4.2.2.9.4.1 l.	4.2.9.4.1 l.	FD-012	T or A
Water Thermal Control System (WTCS)	3.2.2.9.4.1 m.	4.2.2.9.4.1 m.	4.2.9.4.1 m.	FD-013	A
Water Thermal Control System (WTCS)	3.2.2.9.4.1 n.	4.2.2.9.4.1 n.	4.2.9.4.1 n.	ME-049	D or I
VES/WGS requirements	3.2.2.9.4.2a	4.2.2.9.4.2a	4.2.9.4.2 a.	FD-015	T & A
VES/WGS requirements	3.2.2.9.4.2b	4.2.2.9.4.2b	4.2.9.4.2 b.	FD-015	T & A
VES/WGS requirements	3.2.2.9.4.2c	4.2.2.9.4.2c	4.2.9.4.2 c.	FD-015	A
VES/WGS requirements	3.2.2.9.4.2d	4.2.2.9.4.2d	4.2.9.4.2 d.	FD-016	T
VES/WGS requirements	3.2.2.9.4.2e	4.2.2.9.4.2e	4.2.9.4.2 e.	FD-017	T
VES/WGS requirements	3.2.2.9.4.2f	4.2.2.9.4.2f	4.2.9.4.2 f.	FD-018	A or T
VES/WGS requirements	3.2.2.9.4.2g	4.2.2.9.4.2g	4.2.9.4.2 g.	FD-018	A
VES/WGS requirements	3.2.2.9.4.2h	4.2.2.9.4.2h	4.2.9.4.2 h.	FD-018	A
VES/WGS requirements	3.2.2.9.4.2i	4.2.2.9.4.2i	4.2.9.4.2 i.	FD-018	A
VES/WGS requirements	3.2.2.9.4.2j	4.2.2.9.4.2j	4.2.9.4.2 j.	FD-019	NVR
VES/WGS requirements	3.2.2.9.4.2k	4.2.2.9.4.2k	4.2.9.4.2 k.	FD-020	A
VES/WGS requirements	3.2.2.9.4.2l	4.2.2.9.4.2l	4.2.9.4.2 l.	FD-020	NVR
VES/WGS requirements	3.2.2.9.4.2m	4.2.2.9.4.2m	4.2.9.4.2 m.	FD-035	I & A
VRS/VVS requirements	3.2.2.9.4.3a	4.2.2.9.4.3a	4.2.9.4.3 a.	FD-022	T
VRS/VVS requirements	3.2.2.9.4.3b	4.2.2.9.4.3b	4.2.9.4.3 b.	FD-022	T & A

Paragraph Name	FCF-SPC-0004 Sec. 3 Req. Number	FCF-SPC-0004 Sec. 4 Req. Number	SAR-PLN-0007 Sec. 4 Req. Number	VDS No.	Verification Method
VRS/VVS requirements	3.2.2.9.4.3c	4.2.2.9.4.3c	4.2.9.4.3 c.	FD-022	A
VRS/VVS requirements	3.2.2.9.4.3d	4.2.2.9.4.3d	4.2.9.4.3 d.	FD-023	T
VRS/VVS requirements	3.2.2.9.4.3e	4.2.2.9.4.3e	4.2.9.4.3 e.	NA	NVR
ISS nitrogen usage requirements	3.2.2.9.4.4a	4.2.2.9.4.4a	4.2.9.4.4 a.	FD-024	T
ISS nitrogen usage requirements	3.2.2.9.4.4b	4.2.2.9.4.4b	4.2.9.4.4 b.	FD-025	T & A
ISS nitrogen usage requirements	3.2.2.9.4.4c	4.2.2.9.4.4c	4.2.9.4.4 c.	FD-026	T &/or A
ISS nitrogen usage requirements	3.2.2.9.4.4d	4.2.2.9.4.4d	4.2.9.4.4 d.	FD-027	T
COF interfaces	3.2.2.9.5	4.2.2.9.5	4.2.9.5	FN-021	I
SAR to CIR and/or FIR interface	3.2.2.9.6	4.2.2.9.6	4.2.9.6	FN-021	I & T
SAMS data interface	3.2.2.9.7	4.2.2.9.7	4.2.9.7	FN-021	<TBD E-02>
Reliability	3.2.3	4.2.3	4.3	NA	NA
Maintainability	3.2.4	4.2.4	4.4	FN-022	A
SAR maintenance access	3.2.4.1	4.2.4.1	4.4.1	FN-022	D
Maintenance item temporary restraint and stowage	3.2.4.2	4.2.4.2	4.4.2	FN-022	I
Tool usage for maintenance	3.2.4.3	4.2.4.3	4.4.3	FN-022	A
Lockwiring and staking	3.2.4.4	4.2.4.4	4.4.4	FN-022	I
Redundant paths	3.2.4.5	4.2.4.5	4.4.5	FN-022	A
SAR reconfiguration for out-of-tolerance conditions	3.2.4.6	4.2.4.6	4.4.6	FN-022	T
Availability	3.2.5	4.2.5	4.5	FN-022	A
Environmental conditions	3.2.6	4.2.6	4.6	NA	NVR
Shipping and storage environment	3.2.6.1	4.2.6.1	4.6.1	NA	NVR
Nonoperating atmospheric environment	3.2.6.1.1 a.	4.2.6.1.1 a.	4.6.1.1 a.	FN-023	T
Nonoperating atmospheric environment	3.2.6.1.1 b.	4.2.6.1.1 b.	4.6.1.1 b.	FN-023	A
Nonoperating atmospheric environment	3.2.6.1.1 c.	4.2.6.1.1 c.	4.6.1.1 c.	FN-023	A
Operating atmospheric environment	3.2.6.1.2a	4.2.6.1.2a	4.6.1.2 a.	FN-023	T
Operating atmospheric environment	3.2.6.1.2b	4.2.6.1.2b	4.6.1.2 b.	FN-023	A
Operating atmospheric environment	3.2.6.1.2c	4.2.6.1.2c	4.6.1.2 c.	FN-023	A
MPLM/on-orbit environmental conditions	3.2.6.2	4.2.6.2	4.6.2	FN-023	A

Paragraph Name	FCF-SPC-0004 Sec. 3 Req. Number	FCF-SPC-0004 Sec. 4 Req. Number	SAR-PLN-0007 Sec. 4 Req. Number	VDS No.	Verification Method
On-orbit condensation	3.2.6.3	4.2.6.3	4.6.3	EN-001	A
Special environmental conditions	3.2.6.4	4.2.6.4	4.6.4	NA	NVR
Load requirements	3.2.6.4.1 a.	4.2.6.4.1 a.	4.6.4.1 a.	ST-001	A
Load requirements	3.2.6.4.1 b.	4.2.6.4.1 b.	4.6.4.1 b.	ST-001	A
Load requirements	3.2.6.4.1 c.	4.2.6.4.1 c.	4.6.4.1 c.	ME-004	I
Load requirements	3.2.6.4.1 d.	4.2.6.4.1 d.	4.6.4.1 d.	ST-002	A
Load requirements	3.2.6.4.1 e.	4.2.6.4.1 e.	4.6.4.1 e.	ST-001	A
Load requirements	3.2.6.4.1 f.	4.2.6.4.1 f.	4.6.4.1 f.	ST-001	A
Rack requirements	3.2.6.4.2 a.	4.2.6.4.2 a.	4.6.4.2 a.	ST-003	A
Rack requirements	3.2.6.4.2 b.	4.2.6.4.2 b.	4.6.4.2 b.	ST-004	A
Rack requirements	3.2.6.4.2 c.	4.2.6.4.2 c.	4.6.4.2 c.	NA	NVR
Rack requirements	3.2.6.4.2 d.	4.2.6.4.2 d.	4.6.4.2 d.	ME-021	I or A
Rack requirements	3.2.6.4.2 e.	4.2.6.4.2 e.	4.6.4.2 e.	ME-021	A
Rack requirements	3.2.6.4.2 f.	4.2.6.4.2 f.	4.6.4.2 f.	ST-003	A
Rack requirements	3.2.6.4.2 g.	4.2.6.4.2 g.	4.6.4.2 g.	ME-021	A
Rack requirements	3.2.6.4.2 h.	4.2.6.4.2 h.	4.6.4.2 h.	TBD	I
Rack requirements	3.2.6.4.2 i.	4.2.6.4.2 i.	4.6.4.2 i.	FN-024	I
Rack requirements	3.2.6.4.2 j.	4.2.6.4.2 j.	4.6.4.2 j.	FN-024	A
Rack requirements	3.2.6.4.2 k.	4.2.6.4.2 k.	4.6.4.2 k.	FN-024	A, T
Rack requirements	3.2.6.4.2 l.	4.2.6.4.2 l.	4.6.4.2 l.	FN-024	A or T
Rack requirements	3.2.6.4.2 m.	4.2.6.4.2 m.	4.6.4.2 m.	FN-024	A or T
Rack requirements	3.2.6.4.2 n.	4.2.6.4.2 n.	4.6.4.2 n.	FN-024	A
Electrical requirements	3.2.6.4.3	4.2.6.4.3	4.6.4.3	NA	NVR
Steady-state voltage characteristics	3.2.6.4.3.1	4.2.6.4.3.1	4.6.4.3.1	EL-001	T
Ripple voltage characteristics	3.2.6.4.3.2 a.	4.2.6.4.3.2 a.	4.6.4.3.2 a.	EL-002	A
Ripple voltage characteristics	3.2.6.4.3.2 b.	4.2.6.4.3.2 b.	4.6.4.3.2 b.	EL-002	A
Transient voltages	3.2.6.4.3.3	4.2.6.4.3.3	4.6.4.3.3	EL-003	T or A
Fault clearing and protection	3.2.6.4.3.4	4.2.6.4.3.4	4.6.4.3.4	EL-004	A
Non-normal voltage range	3.2.6.4.3.5	4.2.6.4.3.5	4.6.4.3.5	EL-005	A
Power bus isolation	3.2.6.4.3.6 a.	4.2.6.4.3.6 a.	4.6.4.3.6 a.	EL-008	A
Power bus isolation	3.2.6.4.3.6 b.	4.2.6.4.3.6 b.	4.6.4.3.6 b.	EL-008	A
Compatibility with soft start/stop remote power controller (RPC)	3.2.6.4.3.7	4.2.6.4.3.7	4.6.4.3.7	EL-009	T
Surge current	3.2.6.4.3.8	4.2.6.4.3.8	4.6.4.3.8	EL-010	T & A
Reverse energy/current	3.2.6.4.3.9	4.2.6.4.3.9	4.6.4.3.9	EL-011	A
Current protection devices	3.2.6.4.3.10 a.	4.2.6.4.3.10 a.	4.6.4.3.10 a.	NA	T
Current protection devices	3.2.6.4.3.10 b.	4.2.6.4.3.10 b.	4.6.4.3.10 b.	NA	A
Current protection devices	3.2.6.4.3.10 c.	4.2.6.4.3.10 c.	4.6.4.3.10 c.	NA	A
SAR trip ratings	3.2.6.4.3.11	4.2.6.4.3.11	4.6.4.3.11	EL-012	T & D
Interface B complex load impedances	3.2.6.4.3.12	4.2.6.4.3.12	4.6.4.3.12	EL-014	T

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Large signal stability	3.2.6.4.3.13	4.2.6.4.3.13	4.6.4.3.13	EL-023	T & A
Maximum ripple voltage emissions	3.2.6.4.3.14	4.2.6.4.3.14	4.6.4.3.14	EL-015	T & A
Wire derating	3.2.6.4.3.15 a.	4.2.6.4.3.15 a.	4.6.4.3.15 a.	EL-017	A
Wire derating	3.2.6.4.3.15 b.	4.2.6.4.3.15 b.	4.6.4.3.15 b.	EL-017	I or A
Exclusive power feeds	3.2.6.4.3.16	4.2.6.4.3.16	4.6.4.3.16	EL-018	A
Loss of power	3.2.6.4.3.17	4.2.6.4.3.17	4.6.4.3.17	SA-001	T
Electromagnetic compatibility	3.2.6.4.3.18	4.2.6.4.3.18	4.6.4.3.18	EL-020	T, A, &/or I
Electrical grounding	3.2.6.4.3.18.1	4.2.6.4.3.18.1	4.6.4.3.18.1	EL-021	T & A
Electrical bonding	3.2.6.4.3.18.2	4.2.6.4.3.18.2	4.6.4.3.18.2	EL-022	T, A, & I
Cable/wire design and control requirements	3.2.6.4.3.18.3	4.2.6.4.3.18.3	4.6.4.3.18.3	EL-021	T, A, or I
Electromagnetic interference	3.2.6.4.3.18.4	4.2.6.4.3.18.4	4.6.4.3.18.4	EL-020	T & A
Electrostatic discharge	3.2.6.4.3.18.5	4.2.6.4.3.18.5	4.6.4.3.18.5	EL-024	T or A & I
Alternating current (ac) magnetic fields	3.2.6.4.3.18.6	4.2.6.4.3.18.6	4.6.4.3.18.6	EL-020	T
Direct current (dc) magnetic fields	3.2.6.4.3.18.7	4.2.6.4.3.18.7	4.6.4.3.18.7	EL-020	T or A
Corona	3.2.6.4.3.18.8	4.2.6.4.3.18.8	4.6.4.3.18.8	EL-042	A or T
Lightning	3.2.6.4.3.18.9	4.2.6.4.3.18.9	4.6.4.3.18.9	EL-025	A
EMI susceptibility for safety-critical circuits	3.2.6.4.3.18.10	4.2.6.4.3.18.10	4.6.4.3.18.10	EL-019	T & A
Transportability	3.2.7	4.2.7	4.7	FN-025	A
SAR launch and return	3.2.7.1	4.2.7.1	4.7.1	FN-025	A
Design and construction	3.3	4.3	4.8	NA	NVR
Materials, processes, and parts	3.3.1	4.3.1	4.8.1	NA	NVR
SAR specific material requirements	3.3.1.1	4.3.1.1	4.8.1.1	NA	NVR
Materials – general	3.3.1.1.1	4.3.1.1.1	4.8.1.1.1	SA-001	I
Fluids	3.3.1.1.2 a.	4.3.1.1.2 a.	4.8.1.1.2 a.	MP-001	T
Fluids	3.3.1.1.2 b.	4.3.1.1.2 b.	4.8.1.1.2 b.	MP-001	T
Fluids	3.3.1.1.2 c.	4.3.1.1.2 c.	4.8.1.1.2 c.	MP-001	I or A
Connectors	3.3.1.1.3	4.3.1.1.3	4.8.1.1.3	FN-026	I
External cleanliness	3.3.1.1.4 a.	4.3.1.1.4 a.	4.8.1.1.4 a.	MP-002	I
External cleanliness	3.3.1.1.4 b.	4.3.1.1.4 b.	4.8.1.1.4 b.	MP-002	I
Toxic products and formulations	3.3.1.2	4.3.1.2	4.8.1.2	FN-026	I
Volatile organic compounds	3.3.1.3	4.3.1.3	4.8.1.3	FN-026	I
Hazardous materials	3.3.1.4	4.3.1.4	4.8.1.4	FN-026	I
Protective coatings	3.3.1.5	4.3.1.5	4.8.1.5	FN-026	I
Electromagnetic radiation	3.3.2	4.3.2	4.8.2	NA	NVR
Ionizing radiation	3.3.2.1	4.3.2.1	4.8.2.1	NA	NA
Nonionizing radiation	3.3.2.2	4.3.2.2	4.8.2.2	NA	NA
Operating environment	3.3.2.3	4.3.2.3	4.8.2.3	NA	NA
Generated environment	3.3.2.4	4.3.2.4	4.8.2.4	NA	NA

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Nameplates and product marking	3.3.3	4.3.3	4.8.3	NA	NVR
Nameplates	3.3.3.1	4.3.3.1	4.8.3.1	NA	NVR
SAR identification and marking	3.3.3.2	4.3.3.2	4.8.3.2	FN-027	I
SAR component identification and marking	3.3.3.2.1 a. – d.	4.3.3.2.1 a. – d.	4.8.3.2.1 a. – d.	FN-027	I
SAR lighting design	3.3.3.2.2 a.	4.3.3.2.2 a.	4.8.3.2.2 a.	ME-043	T or I
SAR lighting design	3.3.3.2.2 b.	4.3.3.2.2 b.	4.8.3.2.2 b.	ME-043	T
SAR lighting design	3.3.3.2.2 c.	4.3.3.2.2 c.	4.8.3.2.2 c.	ME-043	A or T
SAR lighting design	3.3.3.2.2 d.	4.3.3.2.2 d.	4.8.3.2.2 d.	FN-028	I
SAR lighting design	3.3.3.2.2 e.	4.3.3.2.2 e.	4.8.3.2.2 e.	FN-028	I
SAR lighting design	3.3.3.2.2 f.	4.3.3.2.2 f.	4.8.3.2.2 f.	FN-028	I
Touch temperature warning labels	3.3.3.2.3	4.3.3.2.3	4.8.3.2.3	SA-001	A & I
Connector coding and labeling	3.3.3.2.4 a.	4.3.3.2.4 a.	4.8.3.2.4 a.	ME-020	I
Connector coding and labeling	3.3.3.2.4 b.	4.3.3.2.4 b.	4.8.3.2.4 b.	ME-020	I
Connector coding and labeling	3.3.3.2.4 c.	4.3.3.2.4 c.	4.8.3.2.4 c.	ME-020	I
Portable fire extinguisher (PFE) and fire detection indicator labeling	3.3.3.3 a.	4.3.3.3 a.	4.8.3.3 a.	ME-055	I
Portable fire extinguisher (PFE) and fire detection indicator labeling	3.3.3.3 b.	4.3.3.3 b.	4.8.3.3 a.	ME-054	I
Electrostatic discharge sensitive parts labeling	3.3.3.4	4.3.3.4	4.8.3.4	EL-020	I
Workmanship	3.3.4	4.3.4	4.8.4	FN-029	I
Interchangeability	3.3.5	4.3.5	4.8.5	FN-029	D
On-orbit interchangeability	3.3.5.1	4.3.5.1	4.8.5.1	FN-029	D
Safety	3.3.6	4.3.6	4.8.6	SA-001	A, I, & T
Fire prevention	3.3.6.1	4.3.6.1	4.8.6.1	SA-001	A & I
Smoke detector	3.3.6.1.1 a.	4.3.6.1.1 a.	4.8.6.1.1 a.	ME-052	I
Smoke detector	3.3.6.1.1 b.	4.3.6.1.1 b.	4.8.6.1.1 b.	ME-052	I & D
Maintenance switch, smoke detector, smoke indicator, and SAR fan interfaces	3.3.6.1.1.1	4.3.6.1.1.1	4.8.6.1.1.1	CD-015	I & T
Smoke indicator analog interface characteristics	3.3.6.1.1.2	4.3.6.1.1.2	4.8.6.1.1.2	CD-016	I
Discrete command built-in-test interface characteristics	3.3.6.1.1.3	4.3.6.1.1.3	4.8.6.1.1.3	CD-016	I
Smoke detector electrical interfaces	3.3.6.1.1.4	4.3.6.1.1.4	4.8.6.1.1.4	CD-019	I & T

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Fan ventilation status electrical interfaces	3.3.6.1.1.5	4.3.6.1.1.5	4.8.6.1.1.5	CD-019	I
Rack maintenance switch (rack power switch)/fire detection support interface connector	3.3.6.1.1.6	4.3.6.1.1.6	4.8.6.1.1.6	CD-015	I
Rack maintenance switch (rack power switch)/fire detection support interface connector	3.3.6.1.1.6 a.	4.3.6.1.1.6 a.	4.8.6.1.1.6 a.	NA	NVR
Rack maintenance switch (rack power switch)/fire detection support interface connector	3.3.6.1.1.6 b.	4.3.6.1.1.6 b.	4.8.6.1.1.6 b.	CD-015	I
Rack maintenance switch (rack power switch)/fire detection support interface connector	3.3.6.1.1.6 c.	4.3.6.1.1.6 c.	4.8.6.1.1.6 c.	CD-015	I
Fire detection indicator	3.3.6.1.2 a.	4.3.6.1.2 a.	4.8.6.1.2 a.	ME-054	T & I
Fire detection indicator	3.3.6.1.2 b.	4.3.6.1.2 b.	4.8.6.1.2 b.	ME-054	I
Forced air circulation indication	3.3.6.1.3	4.3.6.1.3	4.8.6.1.3	ME-052	T
Fire parameter monitoring in the SAR	3.3.6.1.4 a.	4.3.6.1.4 a.	4.8.6.1.4 a.	CD-020	T
Fire parameter monitoring in the SAR	3.3.6.1.4 b.	4.3.6.1.4 b.	4.8.6.1.4 b.	CD-020	T
Fire suppression access port accessibility	3.3.6.1.5 a.	4.3.6.1.5 a.	4.8.6.1.5 a.	ME-055	I & A
Fire suppression access port accessibility	3.3.6.1.5 b.	4.3.6.1.5 b.	4.8.6.1.5 b.	ME-055	D
Fire suppressant distribution	3.3.6.1.6	4.3.6.1.6	4.8.6.1.6	ME-055	A or T
SAR front surface temperature	3.3.6.2	4.3.6.2	4.8.6.2	FD-032	A or T
Electrical hazards	3.3.6.3 a.	4.3.6.3 a.	4.8.6.3 a.	EL-041	NVR
Electrical hazards	3.3.6.3 b.	4.3.6.3 b.	4.8.6.3 b.	EL-041	A &/or T
Electrical hazards	3.3.6.3 c.	4.3.6.3 c.	4.8.6.3 c.	EL-041	A &/or T
Electrical hazards	3.3.6.3 d.	4.3.6.3 d.	4.8.6.3 d.	EL-041	A &/or T
Electrical hazards	3.3.6.3 e.	4.3.6.3 e.	4.8.6.3 e.	EL-041	A &/or T
Connector mating	3.3.6.4	4.3.6.4	4.8.6.4	SA-001	A, I, & D
Mating/demating of powered connectors	3.3.6.5	4.3.6.5	4.8.6.5	SA-001	A
Safety-critical circuit redundancy	3.3.6.6	4.3.6.6	4.8.6.6	SA-001	A
Rack maintenance switch (rack power switch)	3.3.6.7	4.3.6.7	4.8.6.7	EL-028	I & D

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Power switches/controls	3.3.6.8 a.	4.3.6.8 a.	4.8.6.8 a.	EL-029	A
Power switches/controls	3.3.6.8 b.	4.3.6.8 b.	4.8.6.8ba.	EL-029	A
Power switches/controls	3.3.6.8 c.	4.3.6.8 c.	4.8.6.8 c.	EL-029	A
Ground fault circuit interrupters (GFCI)/portable equipment dc sourcing voltage	3.3.6.9 a.	4.3.6.9 a.	4.8.6.9 a.	EL-030	A
Ground fault circuit interrupters (GFCI)/portable equipment dc sourcing voltage	3.3.6.9 b.	4.3.6.9 b.	4.8.6.9 b.	EL-030	T
Ground fault circuit interrupters (GFCI)/portable equipment dc sourcing voltage	3.3.6.9 c.	4.3.6.9 c.	4.8.6.9 c.	EL-030	T or A
Ground fault circuit interrupters (GFCI)/portable equipment dc sourcing voltage	3.3.6.9 d.	4.3.6.9 d.	4.8.6.9 d.	EL-030	A & T
Ground fault circuit interrupters (GFCI)/portable equipment dc sourcing voltage	3.3.6.9 e.	4.3.6.9 e.	4.8.6.9 e.	EL-030	T or A
Ground fault circuit interrupters (GFCI)/portable equipment dc sourcing voltage	3.3.6.9 f.	4.3.6.9 f.	4.8.6.9 f.	EL-030	T
Ground fault circuit interrupters (GFCI)/portable equipment dc sourcing voltage	3.3.6.9 g.	4.3.6.9 g.	4.8.6.9 g.	EL-030	A & D
Portable equipment/power cords	3.3.6.10 a.	4.3.6.10 a.	4.8.6.10 a.	EL-031	A
Portable equipment/power cords	3.3.6.10 b.	4.3.6.10 b.	4.8.6.10 b.	EL-031	A
Overload protection	3.3.6.11	4.3.6.11	4.8.6.11	NA	NVR
Device accessibility	3.3.6.11.1	4.3.6.11.1	4.8.6.11.1	EL-013	I
Extractor-type fuse holder	3.3.6.11.2	4.3.6.11.2	4.8.6.11.2	EL-013	D
Overload protection location	3.3.6.11.3	4.3.6.11.3	4.8.6.11.3	EL-013	I
Overload protection identification	3.3.6.11.4	4.3.6.11.4	4.8.6.11.4	EL-013	I
Automatic restart protection	3.3.6.11.5	4.3.6.11.5	4.8.6.11.5	EL-013	D

Paragraph Name	FCF-SPC-0004 Sec. 3 Req. Number	FCF-SPC-0004 Sec. 4 Req. Number	SAR-PLN-0007 Sec. 4 Req. Number	VDS No.	Verification Method
Sharp edges and corners protection	3.3.6.12	4.3.6.12	4.8.6.12	SA-001	I
Holes	3.3.6.13	4.3.6.13	4.8.6.13	ME-007	A & I
Latches	3.3.6.14	4.3.6.14	4.8.6.14	ME-027	I
Screw and bolts	3.3.6.15	4.3.6.15	4.8.6.15	ME-026	A & I
Securing pins	3.3.6.16	4.3.6.16	4.8.6.16	ME-053	A
Levers, cranks, hooks, and controls	3.3.6.17	4.3.6.17	4.8.6.17	ME-053	A & I
Burrs	3.3.6.18	4.3.6.18	4.8.6.18	ME-053	I
Locking wires	3.3.6.19 a.	4.3.6.19 a.	4.8.6.19 a.	ST-009	A
Locking wires	3.3.6.19 b.	4.3.6.19 b.	4.8.6.19 b.	ST-009	I
Audio devices (displays)	3.3.6.20 a.	4.3.6.20 a.	4.8.6.20 a.	ME-044	A
Audio devices (displays)	3.3.6.20 b.	4.3.6.20 b.	4.8.6.20 b.	ME-044	D
Audio devices (displays)	3.3.6.20 c.	4.3.6.20 c.	4.8.6.20 c.	ME-044	A & D
Egress	3.3.6.21	4.3.6.21	4.8.6.21	SA-001	A
Failure tolerance	3.3.6.22	4.3.6.22	4.8.6.22	FN-030	A
Failure propagation	3.3.6.23 a.	4.3.6.23 a.	4.8.6.23 a.	FN-030	A
Failure propagation	3.3.6.23 b.	4.3.6.23 b.	4.8.6.23 b.	FN-030	A
Separation of redundant paths	3.3.6.24	4.3.6.24	4.8.6.24	FN-030	A
Incorrect equipment installation	3.3.6.25	4.3.6.25	4.8.6.25	FN-031	A
Chemical releases	3.3.6.26	4.3.6.26	4.8.6.26	FN-032	A
Single event effect (SEE) ionizing radiation	3.3.6.27	4.3.6.27	4.8.6.27	EN-004	A
Potential hazardous conditions	3.3.6.28 a.	4.3.6.28 a.	4.8.6.28 a.	FN-033	T
Potential hazardous conditions	3.3.6.28 b.	4.3.6.28 b.	4.8.6.28 b.	FN-033	T
Withstand external environment	3.3.6.29	4.3.6.29	4.8.6.29	FN-033	I
Human performance/human engineering	3.3.7	4.3.7	4.8.7	NA	NVR
Strength requirements	3.3.7.1 a. (1)	4.3.7.1 a. (1)	4.8.7.1 a. (1)	ST-005	A or D
Strength requirements	3.3.7.1 a. (2)	4.3.7.1 a. (2)	4.8.7.1 a. (2)	ST-005	A or D
Strength requirements	3.3.7.1 a. (3)	4.3.7.1 a. (3)	4.8.7.1 a. (3)	ST-005	A or D
Strength requirements	3.3.7.1 b.	4.3.7.1 b.	4.8.7.1 b.	ST-005	A or D
Adequate crew clearance	3.3.7.2	4.3.7.2	4.8.7.2	ME-021	A or D
Accessibility	3.3.7.3 a.	4.3.7.3 a.	4.8.7.3 a.	ME-021	A or D
Accessibility	3.3.7.3 b.	4.3.7.3 b.	4.8.7.3 b.	ME-021	A or D
Full size range accommodation	3.3.7.4	4.3.7.4	4.8.7.4	ME-006	A
Housekeeping closures and covers	3.3.7.5	4.3.7.5	4.8.7.5	ME-007	I
Built-in housekeeping control	3.3.7.6 a.	4.3.7.6 a.	4.8.7.6 a.	ME-008	I
Built-in housekeeping control	3.3.7.6 b.	4.3.7.6 b.	4.8.7.6 b.	ME-008	A or D
One-handed operation	3.3.7.7	4.3.7.7	4.8.7.7	ME-009	D
Acoustic requirements	3.3.7.8	4.3.7.8	4.8.7.8	NA	NVR

Paragraph Name	FCF-SPC-0004 Sec. 3 Req. Number	FCF-SPC-0004 Sec. 4 Req. Number	SAR-PLN-0007 Sec. 4 Req. Number	VDS No.	Verification Method
Continuous noise limits	3.3.7.8.1	4.3.7.8.1	4.8.7.8.1	EN-006	A & T
Intermittent noise limits	3.3.7.8.2	4.3.7.8.2	4.8.7.8.2	EN-006	A & T
SAR hardware mounting	3.3.7.9	4.3.7.9	4.8.7.9	NA	NVR
Equipment mounting	3.3.7.9.1	4.3.7.9.1	4.8.7.9.1	ME-011	A or D
Drawers and hinged panel	3.3.7.9.2	4.3.7.9.2	4.8.7.9.2	ME-012	A
Alignment	3.3.7.9.3	4.3.7.9.3	4.9.7.9.3	ME-013	A
Slide-out stops	3.3.7.9.4	4.3.7.9.4	4.8.7.9.4	ME-002	I, A, or D
Push-pull force	3.3.7.9.5	4.3.7.9.5	4.8.7.9.5	ST-006	A
Access	3.3.7.9.6	4.3.7.9.6	4.8.7.9.6	ME-042	A or D
Covers	3.3.7.9.7	4.3.7.9.7	4.8.7.9.7	ME-007	A
Self-supporting covers	3.3.7.9.8	4.3.7.9.8	4.8.7.9.8	ME-007	A
Unique tools	3.3.7.9.9	4.3.7.9.9	4.8.7.9.9	ME-016	A
Connectors	3.3.7.10	4.3.7.10	4.8.7.10	NA	NVR
One-handed operation	3.3.7.10.1	4.3.7.10.1	4.8.7.10.1	ME-017	A or D
Accessibility	3.3.7.10.2 a. (1)	4.3.7.10.2 a. (1)	4.8.7.10.2 a. (1)	ME-018	A or D
Accessibility	3.3.7.10.2 a. (2)	4.3.7.10.2 a. (2)	4.8.7.10.2 a. (2)	ME-018	A or D
Accessibility	3.3.7.10.2 b.	4.3.7.10.2 b.	4.8.7.10.2 b.	ME-018	A
Ease of disconnect	3.3.7.10.3 a.	4.3.7.10.3 a.	4.8.7.10.3 a.	ME-017	A
Ease of disconnect	3.3.7.10.3 b.	4.3.7.10.3 b.	4.8.7.10.3 b.	ME-017	A
Indication of pressure/flow	3.3.7.10.4	4.3.7.10.4	4.8.7.10.4	ME-050	A
Self locking	3.3.7.10.5	4.3.7.10.5	4.8.7.10.5	ME-017	A
Connector arrangement	3.3.7.10.6 a.	4.3.7.10.6 a.	4.8.7.10.6 a.	ME-018	I
Connector arrangement	3.3.7.10.6 b.	4.3.7.10.6 b.	4.8.7.10.6 b.	ME-018	I
Arc containment	3.3.7.10.7	4.3.7.10.7	4.8.7.10.7	EL-026	A
Connector protection	3.3.7.10.8	4.3.7.10.8	4.8.7.10.8	ME-019	A
Connector shape	3.3.7.10.9	4.3.7.10.9	4.8.7.10.9	ME-019	A
Fluid and gas line connectors	3.3.7.10.10	4.3.7.10.10	4.8.7.10.10	FD-001	A
Alignment marks or pin guides	3.3.7.10.11	4.3.7.10.11	4.8.7.10.11	ME-020	I
Orientation	3.3.7.10.12	4.3.7.10.12	4.8.7.10.12	ME-020	A
Hose/cable restraints	3.3.7.10.13 a.	4.3.7.10.13 a.	4.8.7.10.13 a.	ME-022	I
Hose/cable restraints	3.3.7.10.13 b.	4.3.7.10.13 b.	4.8.7.10.13 b.	ME-022	I
Hose/cable restraints	3.3.7.10.13 c.	4.3.7.10.13 c.	4.8.7.10.13 c.	NA	NVR
Hose/cable restraints	3.3.7.10.13 d.	4.3.7.10.13 d.	4.8.7.10.13 d.	ME-022	I
Fasteners	3.3.7.11	4.3.7.11	4.8.7.11	NA	NVR
Non-threaded fasteners status indication	3.3.7.11.1	4.3.7.11.1	4.8.7.11.1	ME-023	D or I
Mounting bolt/fastener spacing	3.3.7.11.2	4.3.7.11.2	4.8.7.11.2	ME-024	I
Multiple fasteners	3.3.7.11.3	4.3.7.11.3	4.8.7.11.3	ME-025	I
Captive fasteners	3.3.7.11.4	4.3.7.11.4	4.8.7.11.4	ME-026	A
Quick release fasteners	3.3.7.11.5 a.	4.3.7.11.5 a.	4.8.7.11.5 a.	ME-026	I
Quick release fasteners	3.3.7.11.5 b.	4.3.7.11.5 b.	4.8.7.11.5 b.	ME-026	I
Threaded fasteners	3.3.7.11.6	4.3.7.11.6	4.8.7.11.6	ME-026	I
Over center latches	3.3.7.11.7 a.	4.3.7.11.7 a.	4.8.7.11.7 a.	ME-027	I
Over center latches	3.3.7.11.7 b.	4.3.7.11.7 b.	4.8.7.11.7 b.	ME-027	I
Over center latches	3.3.7.11.7 c.	4.3.7.11.7 c.	4.8.7.11.7 c.	ME-027	I

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Winghead fasteners	3.3.7.11.8	4.3.7.11.8	4.8.7.11.8	ME-026	I
Fasteners head type	3.3.7.11.9 a.	4.3.7.11.9 a.	4.8.7.11.9 a.	ME-028	I
Fasteners head type	3.3.7.11.9 b.	4.3.7.11.9 b.	4.8.7.11.9 b.	ME-028	I
Fasteners head type	3.3.7.11.9 c.	4.3.7.11.9 c.	4.8.7.11.9 c.	ME-028	I
One-handed operation	3.3.7.11.10	4.3.7.11.10	4.8.7.11.10	ME-029	A or D
Access holes	3.3.7.11.11	4.3.7.11.11	4.8.7.11.11	ME-024	I
Controls and displays	3.3.7.12	4.3.7.12	4.8.7.12	NA	NVR
Controls spacing design requirements	3.3.7.12.1	4.3.7.12.1	4.8.7.12.1	ME-030	I
Accidental actuation	3.3.7.12.2	4.3.7.12.2	4.8.7.12.2	NA	NVR
Protective methods	3.3.7.12.2.1	4.3.7.12.2.1	4.8.7.12.2.1	ME-031	I
Noninterference	3.3.7.12.2.2	4.3.7.12.2.2	4.8.7.12.2.2	ME-030	I
Dead-man controls	3.3.7.12.2.3	4.3.7.12.2.3	4.8.7.12.2.3	SA-001	NVR
Barrier guards	3.3.7.12.2.4	4.3.7.12.2.4	4.8.7.12.2.4	ME-030	I
Recessed switch protection	3.3.7.12.2.5	4.3.7.12.2.5	4.8.7.12.2.5	ME-031	I
Position indication	3.3.7.12.2.6	4.3.7.12.2.6	4.8.7.12.2.6	ME-032	I
Hidden controls	3.3.7.12.2.7	4.3.7.12.2.7	4.8.7.12.2.7	ME-031	I
Hand controllers	3.3.7.12.2.8	4.3.7.12.2.8	4.8.7.12.2.8	ME-031	I
Valve controls	3.3.7.13 a.	4.3.7.13 a.	4.8.7.13 a.	ME-033	I
Valve controls	3.3.7.13 b.	4.3.7.13 b.	4.8.7.13 b.	ME-033	I
Valve controls	3.3.7.13 c.	4.3.7.13 c.	4.8.7.13 c.	ME-033	I
Valve controls	3.3.7.13 d.	4.3.7.13 d.	4.8.7.13 d.	ME-033	I
Valve controls	3.3.7.13 e.	4.3.7.13 e.	4.8.7.13 e.	ME-033	I
Toggle switches	3.3.7.14	4.3.7.14	4.8.7.14	ME-034	I
Restraints and mobility aids	3.3.7.15	4.3.7.15	4.8.7.15	ME-035	D or A
Captive parts	3.3.7.16	4.3.7.16	4.8.7.16	ME-036	I
Handle and grasp area design requirements	3.3.7.17	4.3.7.17	4.8.7.17	NA	NVR
Handles and restraints	3.3.7.17.1	4.3.7.17.1	4.8.7.17.1	ME-037	D or I
Handle location/front access	3.3.7.17.2	4.3.7.17.2	4.8.7.17.2	ME-037	I
Handle dimensions	3.3.7.17.3	4.3.7.17.3	4.8.7.17.3	ME-037	A or D
Non-fixed handles design requirements	3.3.7.17.4 a.	4.3.7.17.4 a.	4.8.7.17.4 a.	ME-037	A & D
Non-fixed handles design requirements	3.3.7.17.4 b.	4.3.7.17.4 b.	4.8.7.17.4 b.	ME-037	D
Non-fixed handles design requirements	3.3.7.17.4 c.	4.3.7.17.4 c.	4.8.7.17.4 c.	ME-037	I & D
Design requirements	3.3.8	4.3.8	4.8.8	NA	NVR
Units of measure	3.3.8.1	4.3.8.1	4.8.8.1	FN-034	I
Margins of safety/factors of safety	3.3.8.2	4.3.8.2	4.8.8.2	SA-001	I
Allowable mechanical properties	3.3.8.3	4.3.8.3	4.8.8.3	FN-034	I
Fracture control	3.3.8.4	4.3.8.4	4.8.8.4	FN-034	I
SAR computer resource requirements	3.4	4.4	4.9	NA	NVR
SAR computer hardware design considerations	3.4.1 a.	4.4.1 a.	4.9.1 a.	NA	T

Paragraph Name	FCF-SPC-0004 Sec. 3 Req. Number	FCF-SPC-0004 Sec. 4 Req. Number	SAR-PLN-0007 Sec. 4 Req. Number	VDS No.	Verification Method
SAR computer hardware design considerations	3.4.1 b.	4.4.1 b.	4.9.1 b.	FN-035	T
SAR computer hardware design considerations	3.4.1 c	4.4.1 c	4.9.1 c.	FN-035	T
Command and data requirements	3.4.1.1	4.4.1.1	4.9.1.1	NA	NVR
Word/byte notations	3.4.1.1.1	4.4.1.1.1	4.9.1.1.1	CD-001	I
Data types	3.4.1.1.2	4.4.1.1.2	4.9.1.1.2	CD-001	I
Data transmissions	3.4.1.1.3 a.	4.4.1.1.3 a.	4.9.1.1.3 a.	CD-001	I
Data transmissions	3.4.1.1.3 b.	4.4.1.1.3 b.	4.9.1.1.3 b.	CD-001	I
Data transmissions	3.4.1.1.3 c.	4.4.1.1.3 c.	4.9.1.1.3 c.	CD-001	I
Consultative committee for space data systems	3.4.1.1.4 a.-c.	4.4.1.1.4 a.-c.	4.9.1.1.4 a.-c.	NA	A or T
CCSDS data packets	3.4.1.1.4.1	4.4.1.1.4.1	4.9.1.1.4.1	CD-001	T
CCSDS primary header	3.4.1.1.4.1.1	4.4.1.1.4.1.1	4.9.1.1.4.1.1	CD-001	T
CCSDS secondary header	3.4.1.1.4.1.2	4.4.1.1.4.1.2	4.9.1.1.4.1.2	CD-001	T
CCSDS data field	3.4.1.1.4.1.3	4.4.1.1.4.1.3	4.9.1.1.4.1.3	CD-003	T
CCSDS application process identification field	3.4.1.1.4.1.4	4.4.1.1.4.1.4	4.9.1.1.4.1.4	NA	T
CCSDS time codes	3.4.1.1.4.2	4.4.1.1.4.2	4.9.1.1.4.2	NA	NVR
CCSDS unsegmented time	3.4.1.1.4.2.1	4.4.1.1.4.2.1	4.9.1.1.4.2.1	CD-004	T
CCSDS segmented time	3.4.1.1.4.2.2	4.4.1.1.4.2.2	4.9.1.1.4.2.2	NA	T
MIL-STD-1553B low rate data link (LRDL)	3.4.1.1.5	4.4.1.1.5	4.9.1.1.5	CD-005	T
Standard messages	3.4.1.1.5.1	4.4.1.1.5.1	4.9.1.1.5.1	CD-005	I & T
Commanding	3.4.1.1.5.2	4.4.1.1.5.2	4.9.1.1.5.2	CD-005	T
Health and status data	3.4.1.1.5.3	4.4.1.1.5.3	4.9.1.1.5.3	CD-005	T & I
Safety data	3.4.1.1.5.4	4.4.1.1.5.4	4.9.1.1.5.4	CD-005	T
Caution and warning	3.4.1.1.5.5	4.4.1.1.5.5	4.9.1.1.5.5	NA	NVR
Class 2 – warning	3.4.1.1.5.5.1	4.4.1.1.5.5.1	4.9.1.1.5.5.1	CD-021	A & T
Class 3 – caution	3.4.1.1.5.5.2	4.4.1.1.5.5.2	4.9.1.1.5.5.2	CD-021	A & T
Class 4 – advisory	3.4.1.1.5.5.3	4.4.1.1.5.5.3	4.9.1.1.5.5.3	CD-021	A & T
Service requests	3.4.1.1.5.6	4.4.1.1.5.6	4.9.1.1.5.6	CD-006	T
File transfer	3.4.1.1.5.7	4.4.1.1.5.7	4.9.1.1.5.7	CD-006	T
Low rate telemetry	3.4.1.1.5.8	4.4.1.1.5.8	4.9.1.1.5.8	CD-006	T
Defined mode codes	3.4.1.1.5.9	4.4.1.1.5.9	4.9.1.1.5.9	CD-007	T
Implemented mode codes	3.4.1.1.5.10	4.4.1.1.5.10	4.9.1.1.5.10	CD-007	T
Illegal commands	3.4.1.1.5.11	4.4.1.1.5.11	4.9.1.1.5.11	CD-008	T
LRDL interface characteristics	3.4.1.1.5.12 a.	4.4.1.1.5.12 a.	4.9.1.1.5.12 a.	NA	I
LRDL interface characteristics	3.4.1.1.5.12 b.	4.4.1.1.5.12 b.	4.9.1.1.5.12 b.	NA	I
Remote terminal hardwired address coding	3.4.1.1.5.12.1	4.4.1.1.5.12.1	4.9.1.1.5.12.1	CD-026	T
LRDL signal characteristics	3.4.1.1.5.12.2	4.4.1.1.5.12.2	4.9.1.1.5.12.2	CD-009	T

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LRDL cabling	3.4.1.1.5.12.3	4.4.1.1.5.12.3	4.9.1.1.5.12.3	EL-032	I
Multi-bus isolation	3.4.1.1.5.12.4	4.4.1.1.5.12.4	4.9.1.1.5.12.4	CD-025	T
Medium rate data link (MRDL)	3.4.1.1.6	4.4.1.1.6	4.9.1.1.6	NA	NVR
MRDL protocol	3.4.1.1.6.1	4.4.1.1.6.1	4.9.1.1.6.1	CD-010	I & T
SAR protocols on the MRDL	3.4.1.1.6.2	4.4.1.1.6.2	4.9.1.1.6.2	CD-010	I & T
MRDL address	3.4.1.1.6.3	4.4.1.1.6.3	4.9.1.1.6.3	CD-011	I & T
SAR MRDL connectivity	3.4.1.1.6.4 a.	4.4.1.1.6.4 a.	4.9.1.1.6.4 a.	CD-011	I
SAR MRDL connectivity	3.4.1.1.6.4 b.	4.4.1.1.6.4 b.	4.9.1.1.6.4 b.	CD-011	T
SAR MRDL connectivity	3.4.1.1.6.4 c.	4.4.1.1.6.4 c.	4.9.1.1.6.4 c.	CD-011	T
SAR MRDL connectivity	3.4.1.1.6.4 d.	4.4.1.1.6.4 d.	4.9.1.1.6.4 d.	CD-011	A
MRDL connector/pin assignments and wire requirements	3.4.1.1.6.5 a.	4.4.1.1.6.5 a.	4.9.1.1.6.5 a.	EL-007	I
MRDL connector/pin assignments and wire requirements	3.4.1.1.6.5 b.	4.4.1.1.6.5 b.	4.9.1.1.6.5 b.	EL-007	I
MRDL connector/pin assignments and wire requirements	3.4.1.1.6.5 c.	4.4.1.1.6.5 c.	4.9.1.1.6.5 c.	EL-007	I
MRDL signal characteristics	3.4.1.1.6.6	4.4.1.1.6.6	4.9.1.1.6.6	CD-012	I & T
MRDL cable characteristics	3.4.1.1.6.7	4.4.1.1.6.7	4.9.1.1.6.7	EL-033	I
Differential characteristic impedance	3.4.1.1.6.7.1	4.4.1.1.6.7.1	4.9.1.1.6.7.1	CD-012	T
SAR to high-rate frame multiplexer (HFM) protocols	3.4.1.1.7	4.4.1.1.7	4.9.1.1.7	NA	T
HDRL physical signaling data rates	3.4.1.1.7.1	4.4.1.1.7.1	4.9.1.1.7.1	CD-013	T & A
HDRL physical signaling data rates	3.4.1.1.7.1 a.	4.4.1.1.7.1 a.	4.9.1.1.7.1 a.	CD-013	T
HDRL physical signaling data rates	3.4.1.1.7.1 b.	4.4.1.1.7.1 b.	4.9.1.1.7.1 b.	CD-013	T
Encoding	3.4.1.1.7.2	4.4.1.1.7.2	4.9.1.1.7.2	CD-013	I & T
SAR HDRL transmitted optical power	3.4.1.1.7.3	4.4.1.1.7.3	4.9.1.1.7.3	CD-014	T
HDRL fiber optic cable	3.4.1.1.7.4	4.4.1.1.7.4	4.9.1.1.7.4	EL-027	I
HDRL fiber optic bend radius	3.4.1.1.7.5	4.4.1.1.7.5	4.9.1.1.7.5	ME-005	I
HDRL connectors and fiber	3.4.1.1.7.6 a.	4.4.1.1.7.6 a.	4.9.1.1.7.6 a.	EL-007	I
HDRL connectors and fiber	3.4.1.1.7.6 b.	4.4.1.1.7.6 b.	4.9.1.1.7.6 b.	EL-007	I

Paragraph Name	FCF-SPC-0004 Sec. 3 Req. Number	FCF-SPC-0004 Sec. 4 Req. Number	SAR-PLN-0007 Sec. 4 Req. Number	VDS No.	Verification Method
HDRL connectors and fiber	3.4.1.1.7.6 c.	4.4.1.1.7.6 c.	4.9.1.1.7.6 c.	EL-007	I
Station support computer (SSC)	3.4.1.1.8 a.	4.4.1.1.8 a.	4.9.1.1.8 a.	CD-024	I
Station support computer (SSC)	3.4.1.1.8 b.	4.4.1.1.8 b.	4.9.1.1.8 b.	CD-024	D
SAR national television systems committee (NTSC) video and audio interface requirements	3.4.1.1.9	4.4.1.1.9	4.9.1.1.9	NA	NVR
SAR NTSC video characteristics	3.4.1.1.9.1	4.4.1.1.9.1	4.9.1.1.9.1	CD-017	T
Pulse frequency modulation NTSC fiber optic video characteristics	3.4.1.1.9.2	4.4.1.1.9.2	4.9.1.1.9.2	CD-017	T
SAR NTSC PFM video transmitted optical power	3.4.1.1.9.3	4.4.1.1.9.3	4.9.1.1.9.3	CD-018	T
Fiber optic cable characteristics	3.4.1.1.9.4	4.4.1.1.9.4	4.9.1.1.9.4	EL-027	I
PFM NSTC video fiber optic cable bend radius	3.4.1.1.9.5	4.4.1.1.9.5	4.9.1.1.9.5	CD-014	I
Flexibility and expansion	3.4.2 a.	4.4.2 a.	4.9.2 a.	FN-036	T
Flexibility and expansion	3.4.2 b.	4.4.2 b.	4.9.2 b.	FN-036	A & T
Flexibility and expansion	3.4.2 c.	4.4.2 c.	4.9.2 c.	FN-036	I
Flexibility and expansion	3.4.2 d.	4.4.2 d.	4.9.2 d.	FN-036	D
Flexibility and expansion	3.4.2 e.	4.4.2 e.	4.9.2 e.	FN-036	T
Flexibility and expansion	3.4.2 f.	4.4.2 f.	4.9.2 f.	FN-036	A
Flexibility and expansion	3.4.2 g.	4.4.2 g.	4.9.2 g.	FN-036	A
Flexibility and expansion	3.4.2 h.	4.4.2 h.	4.9.2 h.	FN-036	A
Software portability	3.4.3 a.	4.4.3 a.	4.9.3 a.	FN-037	T
Software portability	3.4.3 b.	4.4.3 b.	4.9.3 b.	FN-037	T
Data date/time stamps	3.4.4a	4.4.4 a.	4.9.4 a.	FN-038	I & T
Data date/time stamps	3.4.4b	4.4.4 b.	4.9.4 b.	FN-038	I & T
Logistics	3.5	4.5	4.10	NA	NVR
Maintenance	3.5.1	4.5.1	4.10.1	FN-022	D
Supply	3.5.2	4.5.2	4.10.2	FN-022	A
Facilities and facility equipment	3.5.3	4.5.3	4.10.3	NA	NA
Personnel and training	3.6	4.6	4.11	NA	NVR
Personnel	3.6.1 a.	4.6.1 a.	4.11.1 a.	FN-039	D
Personnel	3.6.1 b.	4.6.1 b.	4.11.1 b.	FN-039	T

Paragraph Name	FCF-SPC-0004 Sec. 3 Req. Number	FCF-SPC-0004 Sec. 4 Req. Number	SAR-PLN-0007 Sec. 4 Req. Number	VDS No.	Verification Method
Personnel	3.6.1 c.	4.6.1 c.	4.11.1 c.	FN-039	D
Training	3.6.2	4.6.2	4.11.2	FN-039	D
Major component characteristics	3.7	4.7	4.12	NA	I
Preparation for delivery	5.0	4.7.1	4.13	NA	NVR
Preservation	5.1	4.7.1.1	4.13.1	NA	NVR
Packing	5.2	4.7.1.2	4.13.2	FN-040	I
Launch configured SAR	5.2.1	4.7.1.2.1	4.13.2.1	FN-040	I
Cleanliness	5.2.1.1	4.7.1.2.1.1	4.13.2.1.1	FN-040	I
Procedures	5.2.1.2	4.7.1.2.1.2	4.13.2.1.2	FN-040	I
Flight spares and other equipment	5.2.2	4.7.1.2.2	4.13.2.2	FN-040	I
Marking and labeling	5.3	4.7.1.3	4.13.3	FN-040	NA
Marking for shipment	5.4	4.7.1.4	4.13.2	FN-040	I

APPENDIX F SAR VERIFCATION DATA SHEETS

F.1 Scope.

This appendix contains the VDS's for the SAR.

F.2 SAR System verification data sheets.

<TBD F-01>